MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

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INTRODUCTION.

The MONTHLY WEATHER REVIEW for July, 1897, is based on 2,864 reports from stations occupied by regular and voluntary observers, classified as follows: 144 from Weather Bureau stations; numerous special river stations; 33 from post surgeons, received through the Surgeon General, United States Army; 2,525 from voluntary observers; 96 received through the Southern Pacific Railway Company; 14 from Life-Saving stations, received through the Superintendent United States Life-Saving Service; 32 from Canadian stations; 20 from Mexican stations; 7 from Jamaica, W. I. International simultaneous observations are received from a few stations and used together with trustworthy newspaper extracts and special reports.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Mr. Curtis J. Lyons, Meteorologist to the Government Survey, Honolulu; Dr. Mariano Bárcena, Director of the Central Meteorological Observatory of Mexico; Mr. Maxwell Hall, Government Meteorologist, Kingston, Jamaica; and Commander J. E. Craig, Hydrographer, United States Navy.

The REVIEW is prepared under the general editorial supervision of Prof. Cleveland Abbe. Unless otherwise specifically noted, the text is written by the Editor, but the meteorological tables contained in the last section are furnished by Mr. A. J. Henry, Chief of the Division of Records and Meteorological Data.

Attention is called to the fact that the clocks and self-registers at regular Weather Bureau stations are all set to seventy-fifth meridian or eastern standard time, which is exactly five hours behind Greenwich time, and, as far as practicable, only this standard of time is used in the text of the REVIEW, since all Weather Bureau observations are required to be taken and recorded by it. The standards used by the public in the United States and Canada and by the voluntary observers are believed to generally conform to the modern international system of standard meridians, one hour apart, beginning with Greenwich. Records of miscellaneous phenomena that are reported occasionally in other standards of time by voluntary observers or newspaper correspondents are generally corrected to agree with the eastern standard; otherwise, the local meridian is mentioned.

CLIMATOLOGY OF THE MONTH.

GENERAL CHARACTERISTICS.

The mean barometric pressure was, as usual in this month, low over the large region extending from Hudson Bay southwest to the head of the Gulf of California, but it was abnormally low especially in the Missouri and upper Mississippi valleys.

The mean temperature was decidedly below the normal in the Rocky Mountain Plateau Region, and above normal in the Lake Region, being respectively the lowest and highest on record at several stations in these districts. Precipitation over a small region in New Hampshire, Vermont, western Massachusetts and Connecticut, eastern New York and New Jersey was in remarkable excess, the unprecedented rainfall of 18 to 20 inches occurring in the center of this area; heavy rain also occurred in the Florida Peninsula and in Minnesota, reaching a maximum of 13 inches between Duluth and St. Paul.

ATMOSPHERIC PRESSURE.

[In inches and hundredths.]

The distribution of mean atmospheric pressure reduced to sea level, as shown by mercurial barometers, not reduced to standard gravity, and as determined from observations taken daily at 8 a. m. and 8 p. m. (seventy-fifth meridian time), is shown by isobars on Chart IV. That portion of the reduction to standard gravity that depends on latitude is shown by the numbers printed on the right-hand border.

The *mean pressure* during the current month was highest over the Bermudas and almost equally high on the coast of Washington. It was lowest in Manitoba and Saskatchewan, and almost equally low in Arizona.

The highest reduced pressures were: In the United States, Tatoosh Island, 30.13; Fort Canby, 30.11; Portland, Oreg., Seattle, and Eureka, 30.08; Key West, 30.06; Tampa, Jupiter, and Charleston, 30.05. In Canada, Bermuda, 30.17; Halifax, 30.07; Yarmouth, 30.06; Sydney, 30.03. The lowest were: In the United States, Yuma and Phœnix, 29.76; Miles City, 29.81; Fresno, 29.82; Williston, Moorhead, and Pierre, 29.83. In Canada, Prince Albert, 29.72; Battleford and Winnipeg, 29.80; Medicine Hat and Qu'Appelle, 29.81; Minnedosa and Calgary, 29.83; Swift Current, 29.84.

As compared with the normal for July, the mean pressure was generally deficient in the Mississippi watershed, the South and Middle Atlantic States, and northward to the British Possessions. It was in excess throughout the Rocky Mountain Plateau Region, New England, and the Canadian Provinces.

The greatest excesses were: In the United States, Eastport, 0.09; Winnemucca, 0.08; Tatoosh Island, 0.06; Fort Canby, Baker City, Helena, Salt Lake City, and Denver, 0.05. In Canada, Halifax, 0.15; Yarmouth and Father Point, 0.13;

Sydney, 0.12; Chatham, 0.10. The deficits were: Omaha, 0.09; Miles City, Huron, Moorhead, St. Paul, Marquette, Davenport, 0.08. In Canada, Winnipeg, 0.09; Calgary, 0.07; Swift Current, 0.06; Qu'Appelle, White River, and Port Stanley, 0.05.

As compared with the preceding month of June, the pressures reduced to sea level show a decided rise in New England and the Canadian Provinces, Washington, Oregon, and in the Rocky Mountain Plateau Region, and on the eastern Slope. Elsewhere a slight fall is reported. The greatest rises were: Tatoosh Island, Fort Canby, El Paso, and Eastport, 0.11; Seattle, Portland, Oreg., Santa Fe, 0.09; Omaha, Nantucket, 0.07. In Canada, St. Johns, N. F., Halifax, Yarmouth, 0.14; Charlottetown, 0.13; Sydney, 0.12; Chatham and Father Point, 0.10. The greatest falls were: In the United States, Duluth, Marquette, Port Huron, Detroit, Sandusky, Cleveland, and Erie, 0.05. In Canada, Prince Albert, 0.08; Battleford, Winnipeg, Port Arthur, White River, Port Stanley, 0.05.

AREAS OF HIGH AND LOW PRESSURE.

By Prof. H. A. HAZEN.

During the month there were but four highs sufficiently well defined to be charted, and eight lows. The tracks of these conditions will be found on Charts I and II. The accompanying table gives the principal facts regarding the origin and disappearance and apparent motion or translation of these conditions. As usual, during the summer season, both highs and lows have been ill defined and could be followed only with difficulty. As already noted in May and June, the highs appeared to be offshoots from the permanent high pressure in the Pacific. There was also a slight indication of a translation along the Pacific Coast from south to north before the advance into the country. The paths of all of the highs crossed the country from the north Pacific to the south Atlantic Coast. The general course of the lows was to the north of Montana, and nearly every track was along the north border of the country. Numbers II, V, VII, and VIII of the lows reached the north Atlantic Coast, but the other four vanished to the west of the Mississippi River and Great Lakes.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	7, p. m.	47	128	12, a. m.	35	102	1,930	4.5	428	17.8
II	10, a. m.	53	109	14, a. m.	31	89	1,910	3.5	545	22.7
III	16, p. m.	46	128	23, p. m.	26	80	3,510	7.0	501	20.8
IV	24, p. m.	45	126	31, p. m.	31	78	3,520	7.0	503	21.0
Total							10,870	22.0	1,977	
Mean of 4 paths							2,717		494	20.6
Mean of 22.0 days									494	20.6
Low areas.										
I	1, a. m.	52	115	5, a. m.	51	94	1,420	4.0	355	14.8
II	5, p. m.	54	113	14, p. m.	49	68	4,540	9.0	504	20.9
III	12, a. m.	54	116	16, a. m.	40	88	2,410	4.0	602	25.1
IV	14, p. m.	51	116	18, a. m.	52	100	1,430	3.5	409	17.0
V	19, p. m.	50	114	25, a. m.	44	64	2,540	5.5	463	19.3
VI	21, a. m.	53	115	24, a. m.	41	96	1,260	3.0	420	17.5
VII	24, p. m.	53	103	30, p. m.	44	62	3,010	6.0	501	20.8
VIII	27, p. m.	52	111	*	43	63	2,680	5.5	488	20.3
Total							19,290	40.5	3,742	
Mean of 8 paths							2,411		468	19.5
Mean of 40.5 days									476	19.8

* August 2, a. m.

LOCAL STORMS.

By A. J. HENRY, Chief of Division of Records and Meteorological Data.

3d, 6th, 8th.—Unusually heavy rainfall, accompanied by winds of sufficient force in some cases to unroof buildings and prostrate frail structures, prevailed over portions of Minnesota and northern Wisconsin. It is estimated that the streets, parks, etc., in the city of Duluth were damaged by the rain and wind of the 3d to the extent of $50,000.

On the 6th a tornado formed a short distance west of Lowery, Pope County, Minn. It traveled about 6 miles in a northeasterly direction in a path from 25 to 80 rods in width. Two persons were killed and 8 injured. Its approach was very generally observed and almost everyone had an opportunity to escape.

12th, 13th, 14th.—Many severe thunderstorms occurred on these dates throughout Michigan, Ohio, and eastward to the Atlantic. The winds on the coast from New Jersey to Maine were unusually severe for the season. Three lives were lost by drowning, and several small craft were wrecked.

22d.—A very severe thunderstorm and squall wind swept over Philadelphia and vicinity. Damages by hail, wind, and water were sustained in all parts of the city.

23d.—A violent thunderstorm experienced in New York on the afternoon of this date. Lightning struck in many places, including several of the high structures in the neighborhood of the City Hall. Beyond shattering the flagstaffs, but little damage was done.

30th.—A minor tornado was observed at 7 p. m., central time, near the town of San Jose, Ill. One house was destroyed and 6 of the inmates killed. Five other persons were injured. The path of the storm was quite narrow; its length could not be ascertained.

TEMPERATURE OF THE AIR.

[In degrees Fahrenheit.]

The mean temperatures and the departures from the normal, as determined from records of the maximum and minimum thermometers, are given in Table I for the regular stations of the Weather Bureau, which also gives the height of the thermometers above the ground at each station. The mean temperature is given for each station in Table II, for voluntary observers.

The *monthly mean temperatures* published in Table I, for the regular stations of the Weather Bureau, are the simple means of all the daily maxima and minima; for voluntary stations a variety of methods of computation is necessarily allowed, as shown by the notes appended to Table II. The mean temperatures given in Table III for Canadian stations are the simple means of 8 a. m. and 8 p. m. simultaneous observations.

The *regular diurnal period* in temperature is shown by the hourly means given in Table V for 29 stations selected out of 82 that maintain continuous thermograph records.

The *distribution of the observed monthly mean* temperature of the air over the United States and Canada is shown by the dotted isotherms on Chart IV; the lines are drawn over the Rocky Mountain Plateau region, although the temperatures have not been reduced to sea level, and the isotherms, therefore, relate to the average surface of the country occupied by our observers; such isotherms are controlled largely by the local topography, and should be drawn and studied in connection with a contour map.

The *highest mean temperatures* were: In the United States, Yuma, 91.1; Phœnix, 89.6; San Antonio, 85.0; Shreveport, 84.8; Palestine, 84.4; Galveston and Port Eads, 84.2. In Canada, Bermuda, 78.4; Toronto and Ottawa, 71.2; Parry Sound, Montreal, 70.6; Kingston, 70.2; Port Stanley, 70.1. The *lowest* were: In the United States, Point Reyes Light,

54.4; Tatoosh Island, 55.0; Port Angeles, 55.1; Eureka, 55.8; Fort Canby, 57.8. In Canada, Banff, 52.6; Esquimault, 56.5; St. Johns, N. F., 56.8; Calgary, 57.5; Father Point, 57.7; Edmonton, 58.1.

As compared with the normal for July, the mean temperature for the current month was in excess slightly on the California coast, but decidedly throughout the Mississippi watershed, Lake Region, northern New England, and the Maritime Provinces. It was decidedly deficient over the Rocky Mountain Plateau Region and slightly on the New England Coast. It was the coldest on record for the eastern portions of Washington and Oregon.

The greatest excesses were: In the United States, Sault Ste. Marie, 5.5; Buffalo, 4.7; Northfield, 4.5; Milwaukee, 3.8; Alpena, 3.7; Green Bay, 3.5; Topeka, 3.4. In Canada, White River, 6.5; Parry Sound, 5.6; Saugeen, 5.4; Rockliffe, 4.6. The deficits were: In the United States, Walla Walla, 4.6; Baker City, 4.4; Lander, 4.3; El Paso, 3.7; Salt Lake City, 3.6. In Canada, St. Johns, N. F., 4.2; Esquimault, 3.5; Battleford, 2.9; Edmonton and Medicine Hat, 2.8.

Considered by districts the mean temperatures of the current month show departures from the normal as given in Table I. The greatest positive departures were: Lower Lake, 2.2; Upper Lake, 3.0; Missouri Valley, 1.5. The greatest negative departures were: Southern Plateau, 2.4; Northern Plateau, 3.6.

In Canada, Prof. R. F. Stupart says:

Temperature was a little below average in British Columbia and the Northwest Territories; it was from 0° to 4° above in Manitoba, and from 3° to 7° above in the Province of Ontario. In Quebec, between Montreal and Quebec City, it was 4° above, and thence the difference diminished to about 1° above at Gaspe. In New Brunswick and Nova Scotia there was a general excess ranging between 1° and 3°.

The *years of highest and lowest mean temperatures* for July are shown in Table I of the REVIEW for July, 1894. The mean temperature for the current month was the highest on record at: Palestine, 84.4; Parkersburg, 76.5; Milwaukee, 73.2; Alpena, 69.0; Sault Ste. Marie, 67.6. It was the lowest on record at: Baker City, 62.2; Spokane, 65.2; Winnemucca, 68.1; Walla Walla, 70.6; Salt Lake City, 71.9.

The *maximum and minimum temperatures* of the current month are given in Table I. The highest maxima were: 112, Yuma (10th); 110, Fresno (11th); 107, Phœnix (30th); 106, Red Bluff (13th); 105, Walla Walla and Sacramento (11th), Abilene (26th). The lowest maxima were: 62, Tatoosh Island (13th); 67, Eureka (18th), Port Angeles (9th); 69, Fort Canby (13th); 74, Astoria (10th), 78, Block Island and Woods Hole (16th). The highest minima were: 74, Port Eads (frequently); 72, Corpus Christi (14th); 71, New Orleans (17th), Charleston (14th); 70, Key West (7th), Tampa (17th), Galveston (27th). The lowest minima were: 34, Idaho Falls (19th); 35, Winnemucca (8th); 37, Baker City (7th); 39, Carson City (8th); 40, Cheyenne (frequently); 41, Lander 18th.

The *years of highest maximum and lowest minimum temperatures* for July are given in the last four columns of Table I of the REVIEW for July, 1896. During the current month the maximum temperatures were equal to or above the highest on record at: Kansas City, 102; Sandusky, 100; Rochester and Parkersburg, 99; Alpena, 98; Cleveland, 97; Northfield and Buffalo, 95; Erie, 94; Grand Haven, 93. The minimum temperatures were equal to or below the lowest on record at: Winnemucca, 35; Santa Fe and Pueblo, 43; San Francisco, 47; Abilene, 61.

The *greatest daily range of temperature and the data for computing the extreme and mean monthly ranges* are given for each of the regular Weather Bureau stations in Table I. The largest values of the greatest daily ranges were: Fresno, 52; Idaho Falls, 50; Havre and Pueblo, 45; Cheyenne, 44; Walla Walla, Winnemucca, and Carson City, 43. The smallest values were: Tatoosh Island and Hatteras, 11; Key West, 13; Port Eads, San Diego, and Fort Canby, 15; Nantucket, 16.

Among the *extreme monthly ranges* the largest were: Idaho Falls, 62; Winnemucca, 61; Pueblo and Fresno, 58; Baker City, 56; Walla Walla and Miles City, 55. The smallest values were: Tatoosh Island, 14; Port Eads, 19; Fort Canby, San Diego, and Hatteras, 20; Key West and Eureka, 21.

Accumulated monthly departures from normal temperatures from January 1 to the end of the current month are given in the second column of the following table, and the average departures are given in the third column, for comparison with the departures of current conditions of vegetation from the normal condition.

Districts.	Accumulated departures.		Districts.	Accumulated departures.	
	Total.	Average.		Total.	Average.
	°	°		°	°
New England	+ 3.7	+ 0.5	Ohio Valley and Tenn.	— 1.1	— 0.2
Middle Atlantic	+ 0.7	+ 0.1	North Dakota	— 5.0	— 0.7
South Atlantic	+ 0.7	+ 0.1	Northern Slope	— 2.1	— 0.3
Florida Peninsula	+ 0.1	+ 0.0	Southern Slope	— 0.2	— 0.0
East Gulf	+ 1.9	+ 0.3	Southern Plateau	— 6.1	— 0.9
West Gulf	+ 6.2	+ 0.9	Middle Plateau	— 8.0	— 1.1
Lower Lake	+ 3.6	+ 0.5	North Pacific	— 1.2	— 0.2
Upper Lake	+ 9.2	+ 1.3	Middle Pacific	— 1.6	— 0.2
Upper Mississippi Valley	+ 2.6	+ 0.4	South Pacific	— 4.1	— 0.6
Missouri Valley	+ 2.1	+ 0.3			
Middle Slope	+ 2.9	+ 0.4			
Northern Plateau	+ 5.4	+ 0.8			

MOISTURE.

The *quantity of moisture* in the atmosphere at any time may be expressed by the weight of the vapor coexisting with the air contained in a cubic foot of space, or by the tension or pressure of the vapor, or by the temperature of the dew-point. The mean dew-point for each station of the Weather Bureau, as deduced from observations made at 8 a. m. and 8 p. m., daily, is given in Table I.

The *rate of evaporation* from a special surface of water on muslin at any moment determines the temperature of the wet-bulb thermometer. The mean wet-bulb temperature is now published in Table I; it is always intermediate, and generally about half way between the temperature of the air and of the dew-point. The quantity of water evaporated in a unit of time from the muslin surface may be considered as depending essentially upon the wet-bulb temperature, the dew-point, and the wind.

The *relative humidity*, or the ratio between the moisture that is present in the air and the moisture that it would contain if saturated at its observed temperature is given in Table I as deduced from the 8 a. m. and 8 p. m. observations. The general average for a whole day, or any other interval, would properly be obtained from the data given by an evaporometer, but may also be obtained, approximately, from frequent observations of the relative humidity.

PRECIPITATION.

[In inches and hundredths.]

The *distribution of precipitation* for the current month, as determined by reports from about 2,500 stations, is exhibited on Chart III. The numerical details are given in Tables I, II, and III. The total precipitation for the current month was largest, exceeding 19 inches in central and western Connecticut, and exceeding 6 inches over the greater part of New England and the Middle Atlantic coast region. It was also unusually large in Wisconsin and the Florida Peninsula. Little or no rain fell in Oregon, California, southern Idaho, Nevada, Utah, parts of Arizona and New Mexico.

The larger values for regular stations were: New Haven, 16.63; New York, 9.52; Charleston, 9.42; Kittyhawk, 9.06; Hatteras, 8.98; Buffalo, 8.29; Savannah, 8.10; Hannibal and Northfield, 8.04; Moorhead, 8.02; Atlantic City, 8.01. In Canada, Swift Current, 6.27; St. Johns, N. F., 6.09; Bermuda, 5.79; Calgary, 5.54; Banff, 5.34.

Details as to *excessive precipitation* are given in Tables XI and XII.

The *diurnal variation*, as shown by tables of hourly means of the total precipitation, deduced from the self-registering gauges kept at the regular stations of the Weather Bureau, is not now tabulated.

The *current departures* from the normal precipitation are given in Table I, which shows that precipitation was in excess over a narrow belt extending from New Hampshire and Massachusetts to Virginia, and thence westward to the Rocky Mountain Plateau. It was especially deficient in the interior of the Gulf States. The large excesses were: New Haven, 11.7; Duluth, 5.6; New York, 5.3; Buffalo, 5.1; Northfield and Hannibal, 4.9; Atlantic City, 4.6; Nashville, 4.3; Moorhead, 4.1. The large deficits were: Port Eads, 6.1; Pensacola, 4.5; Tampa, 3.6; Montgomery, 3.1; Little Rock, 3.0.

The *average departure* for each district is given in Table I. By dividing each current precipitation by its respective normal the following corresponding percentages are obtained (precipitation is in excess when the percentage of the normal exceeds 100):

Above the normal: New England, 177; middle Atlantic, 144; south Atlantic, 109; east Gulf, 142; Ohio Valley and Tennessee, 132; lower Lake, 145; upper Lake, 126; North Dakota, 128; upper Mississippi, 119; southern Slope, 111; southern Plateau, 107; middle Plateau, 138; north Pacific, 132.

Normal: northern Plateau and southern Pacific, 100.

Below the normal: Florida Peninsula, 87; west Gulf, 37; Missouri Valley, 80; northern Slope, 94; middle Slope, 96; middle Pacific, 9.

In Canada, Prof. R. F. Stupart says:

The rainfall was a little above average in British Columbia. It was very decidedly above in Alberta, where the excess was from 1 to 3 inches, but in Assiniboia and Saskatchewan, except locally, the difference from average was not great, and in some places there was a deficiency. In western Manitoba there was a small deficiency, but in the eastern part of the Province and thence throughout the Lake Region, there was a marked excess, except in the southwestern counties of Ontario, and also in a small district north of Lake Superior. In the central and more northern parts of Ontario the fall was from double to three times the average amount. In Quebec it was about average, and in the Maritime Provinces there were no marked departures from average, except in the extreme eastern portion, and near the upper part of the Bay of Fundy, where there was a deficiency.

The *total accumulated monthly departures* from January 1 to the end of the current month are given in the second column of the following table; the third column gives the percentage of the current accumulated precipitation relative to its normal value.

Districts.	Accumulated departures.	Accumulated precipitation.	Districts.	Accumulated departures.	Accumulated precipitation.
	Inches.	*Per ct.*		*Inches.*	*Per ct.*
New England	+ 1.80	107	Middle Atlantic	− 0.40	98
Florida Peninsula	+ 3.80	114	South Atlantic	− 1.70	95
Ohio Valley and Tenn.	+ 2.50	109	East Gulf	− 2.00	94
Upper Lake	+ 0.20	101	West Gulf	− 5.80	77
North Dakota	+ 0.80	106	Lower Lake	− 0.70	97
Upper Mississippi Valley	+ 3.00	114	Missouri Valley	− 0.30	99
Middle Slope	+ 0.90	106	Northern Slope	− 1.00	90
Southern Slope	+ 2.30	119	North Pacific	− 1.50	95
Southern Plateau	+ 2.70	164	Middle Pacific	− 2.30	88
Middle Plateau	+ 0.20	103			
Northern Plateau	+ 0.30	103			
South Pacific	+ 0.80	110			

The *years of greatest and least precipitation* for July are given in the REVIEW for July, 1890. The precipitation for the current month was the greatest on record at: Buffalo, 8.29; Hannibal and Northfield, 8.04; Moorhead, 8.02; Atlantic City, 8.01; Rochester, 6.37; Nantucket, 4.32. It was the least on record at: Corpus Christi, 0.00; Pensacola, 2.19.

SNOWFALL.

The *total monthly snowfall* at each station, if any occurs, is given in Tables I and II. The chart of geographical distribution is omitted for this month.

HAIL.

The following are the dates on which hail fell in the respective States:

Alabama, 16. Arkansas, 29. California, 21. Colorado, 8, 9, 10, 14, 17, 23, 24, 26, 31. Delaware, 23, 31. Georgia, 3, 18, 21. Idaho, 1, 7, 17, 26. Illinois, 9, 12, 24, 25, 30. Indiana, 9, 10, 16, 23, 30, 31. Iowa, 2, 3, 6, 11, 22, 23, 24, 30. Kansas, 1, 3, 4, 24, 28. Kentucky, 4, 6, 7, 9, 10, 11, 17, 19, 23, 24. Maine, 23, 31. Maryland, 2, 7, 11, 12, 14, 17, 18, 19, 23, 31. Massachusetts, 31. Michigan, 17, 29, 30. Minnesota, 2, 3, 5, 6, 11, 18, 19, 29. Missouri, 10, 11, 15, 25. Montana, 6, 7, 17, 18, 22, 30. Nebraska, 5, 9, 11, 26, 27. Nevada, 16, 22, 23. New Hampshire, 6, 17, 31. New Jersey, 2, 3, 14, 22, 23. New Mexico, 1, 9, 16 to 19, 27, 28. New York, 6, 10, 11, 14, 15, 20, 22. North Carolina, 3, 14, 23. North Dakota, 3, 4, 5, 10, 14, 16, 17, 25, 31. Ohio, 5, 11, 14, 17, 19, 20, 22, 23, 24, 31. Oregon, 1, 6, 20. Pennsylvania, 1, 7, 11, 14, 17, 18, 22, 23, 30, 31. South Dakota, 3, 4, 5, 20, 29, 30. Tennessee, 16, 24, 25. Texas, 16, 17, 27, 28. Utah, 16, 21. Virginia, 7, 14, 23. Washington, 7. West Virginia, 18, 23. Wisconsin, 5, 11, 25. Wyoming, 14, 17, 19, 30.

HEAVY RAINS.

Among the remarkable rains of the month are the following items, taken from the printed reports of the respective State sections:

Indiana.—Evansville, Vanderburg County: On July 1, during a heavy thunderstorm, 4.75 inches of rain fell between 3 a. m and 8 a. m, seventy-fifth meridian time. Jeffersonville, Clark County: On the 10th, from 12:15 p. m. to 2:02, 4.74 inches of water fell during a heavy storm; a portion of it fell as large hail, between 12:18 and 12:40, doing considerable damage Liberty, Union County: On the evening of July 23, hailstones appearing as if cut from a thick, flat piece of frozen snow, and others like great chunks broken from cakes of ice.

Maryland.—Jewell, Anne Arundel County: On the 26th, from 6 p. m. to the 27th at noon, there fell 14.75 inches; the 2-inch receiver of the rain gauge was filled seven times from the overflow cylinder, and the eighth pouring gave the additional 0.75. The voluntary observer, Mr. Joseph Plummer, states that all the residents of that section agree that it was the heaviest rainfall they had ever witnessed.

New England.—The remarkable rain of the 12–14th lasted from thirty to thirty-six hours in western Connecticut and Massachusetts, and at the close of the storm it was found that from 5 to over 10 inches had fallen in many sections, exceeding previous records for any single storm; Southington, Conn., had 10.30 inches (in 33 hours); Bridgeport, Conn., had 9.39 inches; Windsor and Hartford, Conn., 9.22 and 9.17 inches, respectively, while at the mouth of the Connecticut River the measurement was nominal; farther north, through western Massachusetts and into Vermont, New Hampshire, and Maine, the amounts reached 5 and 6 inches, but along the eastern coast the precipitation was very small.

The second heaviest storm of the month came on the 22d. This had remarkable local irregularities in Connecticut, where the precipitation was the greatest. In some localities the storm resembled a cloudburst, and the consequent floods were worse than for many years. Finally, on the 29th, the third deluge occurred, accompanied by severe electrical disturbances. These storms created flood conditions in various regions, which assumed altogether colossal proportions. Several lives were lost and thousands upon thousands of dollars' worth of damage must have been done to bridges, highways, etc. On the 16th the Connecticut River at Hartford, Conn., was nearly 20 feet above low-water mark; on the 23d it was 11 feet above, and on the 30th, 19.45 above.

Wisconsin.—Butternut Station (one of the highest stations in the State), Ashland County: The voluntary observer, Mr. John J. Hayden, reports for the month 15.11 inches, out of which 10.15 fell between early morning of the 24th and some time late in the night of the 24–25th. There was no thunder with this rain.

WIND.

The *prevailing winds* for July, 1897, viz, those that were recorded most frequently, are shown in Table I for the regular Weather Bureau stations.

The *resultant winds*, as deduced from the personal observations made at 8 a. m. and 8 p. m., are given in Table VIII. These latter resultants are also shown graphically on Chart IV, where the small figure attached to each arrow shows the number of hours that this resultant prevailed, on the assumption that each of the morning and evening observations represents one hour's duration of a uniform wind of average velocity. These figures indicate the relative extent to which winds from different directions counterbalanced each other.

Maximum wind velocities are given in Table I, which also gives the altitudes of the Weather Bureau anemometers above the ground. Maxima of 50 miles or more per hour were reported during this month at regular stations of the Weather Bureau as follows (maximum velocities are averages for five minutes; extreme velocities are gusts of shorter duration, and are not given in this table):

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
		Miles				*Miles*	
Amarillo, Tex	20	52	w.	Fort Canby, Wash.	15	7	s.
Chicago, Ill	5	72	w.	Idaho Falls, Idaho	17	50	sw.
Des Moines, Iowa	23	50	nw.	Miles City, Mont	22	51	w.
El Paso, Tex	15	50	ne.	New York, N. Y	23	54	nw.
Do	20	52	ne.	Shreveport, La	17	56	s.
Do	23	60	sw.	Sioux City, Iowa	2	57	w.
Do	26	56	sw.	Woods Hole, Mass	14	52	se.

SUNSHINE AND CLOUDINESS.

The quantity of sunshine, and therefore of heat, received by the atmosphere as a whole is very nearly constant from year to year, but the proportion received by the surface of the earth depends upon the absorption by the atmosphere, and varies largely with the distribution of cloudiness. The sunshine is now recorded automatically at 22 regular stations of the Weather Bureau by its photographic, and at 40 by its thermal effects; at one of these stations records are kept by both methods. The photographic record sheets show the apparent solar time, but the thermometric records show seventy-fifth meridian time; for convenience the results are all given in Table X for each hour of local mean time. In order to complete the record of the duration of cloudiness these registers are supplemented by special personal observations of the state of the sky near the sun in the hours after sunrise and before sunset, and the cloudiness for these hours has been added as a correction to the instrumental records, whence there results a complete record of the duration of sunshine from sunrise to sunset.

The average cloudiness of the whole sky is determined by numerous personal observations at all stations during the daytime, and is given in the column "average cloudiness" in Table I; its complement, or percentage of clear sky, is given in the last column of Table X for the 61 stations at which instrumental self-registers are maintained.

COMPARISON OF DURATIONS AND AREAS.

The sunshine registers give the *durations* of effective sunshine whence the durations relative to possible sunshine are derived; the observers' personal estimates give the percentage of *area* of clear sky. These numbers have no necessary relation to each other, since stationary banks of clouds may obscure the sun without covering the sky, but when all clouds have a steady motion past the sun and are uniformly scattered over the sky, the percentages of duration and of area agree closely. For the sake of comparison, these percentages have been brought together, side by side, in the following table, from which it appears that, in general, the instrumental records of percentages of durations of sunshine are almost always larger than the observers' personal estimates of percentages of area of clear sky; the average excess for July, 1897, is 11 per cent for photographic and 13 per cent for thermometric records.

The details are shown in the accompanying table, in which the stations are arranged according to the *total possible* duration of sunshine, and not according to the *observed* duration.

Difference between instrumental and personal observations of sunshine.

Stations.	Latitude.		Apparatus.	For whole month.		Instrumental record of sunshine.			
				Total possible.	Personal.	Photographic.	Difference.	Thermometric.	Difference.
	°	′		*Hrs.*	%	%	%	%	%
Key West, Fla	24	34	T.	419.1	40	......	......	67	+27
Tampa, Fla	27	57	T.	424.9	52	......	......	55	+ 3
Galveston, Tex	29	18	P.	427.4	79	88	+ 9	......	......
New Orleans, La	29	58	T.	429.6	45	......	......	46	+ 1
Savannah, Ga	32	05	P.	434.5	48	70	+22	......	......
Vicksburg, Miss	32	22	T.	434.5	62	......	......	85	+23
San Diego, Cal	32	43	P.	437.2	81	75	— 6	......	......
Charleston, S. C.	32	47	T.	437.2	51	......	......	65	+14
Phœnix, Ariz	33	28	P.	437.2	79	87	+ 8	......	......
Atlanta, Ga	33	45	T.	439.7	37	......	......	47	+10
Los Angeles, Cal	34	03	P.	439.7	65	75	+10	......	......
Wilmington, N. C.	34	14	T.	439.7	42	......	......	52	+10
Little Rock, Ark	34	45	T.	442.0	56	......	......	82	+26
Chattanooga, Tenn	35	04	T.	442.0	46	......	......	53	+ 7
Santa Fe, N. Mex	35	41	P.	444.3	56	65	+ 9	......	......
Raleigh, N. C.	35	45	T.	444.3	36	......	......	72	+36
Nashville, Tenn	36	10	T.	444.3	55	......	......	69	+14
Fresno, Cal	36	43	T.	447.4	91	......	......	94	+ 3
Dodge City, Kans	37	45	P.	450.1	73	84	+11	......	......
San Francisco, Cal	37	48	T.	450.1	70	......	......	74	+ 4
Louisville, Ky	38	15	T.	450.1	49	......	......	73	+24
St. Louis, Mo	38	38	T.	453.0	60	......	......	81	+21
Washington, D. C	38	54	P.	453.0	50	62	+12	......	......
Kansas City, Mo	39	05	P.	453.0	67	76	+ 9	......	......
Cincinnati, Ohio	39	06	T.	453.0	61	......	......	75	+14
Parkersburg, W. Va	39	16	T.	453.0	......	......	......	......	......
Baltimore, Md	39	18	T.	453.0	44	......	......	41	— 3
Atlantic City, N. J	39	22	P.	453.0	46	63	+17	......	......
Denver, Colo	39	45	P.	455.2	50	70	+20	......	......
Indianapolis, Ind	39	46	T.	455.2	58	......	......	80	+22
Philadelphia, Pa	39	57	T.	455.2	32	......	......	55	+23
Columbus, Ohio	39	58	T.	455.2	52	......	......	76	+24
Harrisburg, Pa	40	16	T.	455.2	41	......	......	63	+22
Pittsburg, Pa	40	32	T.	458.6	48	......	......	52	+ 4
New York, N. Y	40	43	T.	458.6	37	......	......	50	+13
Salt Lake City, Utah	40	46	P.	458.6	62	82	+20	......	......
Eureka, Cal	40	48	P.	458.6	61	58	— 3	......	......
Cheyenne, Wyo	41	08	P.	458.6	56	66	+10	......	......
Omaha, Nebr	41	16	P.	458.6	66	77	+11	......	......
Cleveland, Ohio	41	30	T.	461.8	52	......	......	60	+ 8
Des Moines, Iowa	41	35	T.	461.8	69	......	......	71	+ 2
Chicago, Ill	41	53	T.	461.8	59	......	......	59	0
Erie, Pa	42	07	T.	461.8	46	......	......	60	+14
Binghamton, N. Y	42	08	T.	461.8	37	......	......	52	+15
Detroit, Mich	42	20	T.	461.8	62	......	......	76	+14
Boston, Mass	42	21	T.	461.8	35	......	......	48	+13
Dubuque, Iowa	42	30	T.	461.8	69	......	......	73	+ 4
Albany, N. Y	42	39	T.	465.2	41	......	......	68	+27
Buffalo, N. Y	42	53	T.	465.2	35	......	......	66	+31
Rochester, N. Y	43	08	T.	465.2	47	......	......	52	+ 5
Idaho Falls, Idaho	43	29	T.	465.2	63	......	......	66	+ 3
Portland, Me	43	39	T.	468.4	31	......	......	45	+14
Northfield, Vt	44	10	P.	468.4	31	44	+13	......	......
Eastport, Me	44	54	P.	471.7	30	47	+17	......	......
St. Paul, Minn	44	58	P.	471.7	47	62	+15	......	......
Minneapolis, Minn	44	59	T.	471.7	......	......	......	46	......
Portland, Oreg	45	32	T.	475.7	66	......	......	69	+ 3
	45	32	P.	475.7	66	66	0	......	......
Helena, Mont	46	34	P.	479.6	56	66	+10	......	......
Bismarck, N. Dak	46	47	P.	479.6	56	58	+ 2	......	......
Seattle, Wash	47	38	T.	483.2	59	......	......	64	+ 5
Spokane, Wash	47	40	T.	483.2	55	78	+23	......	......

ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms are given in Table IX, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

Thunderstorms.—The dates on which the number of reports

of thunderstorms for the whole country were most numerous were: 9th, 249; 10th, 294; 11th, 282; 18th, 243; 23d, 254. They were least numerous on the 12th, 81; 29th, 80.

Reports were most numerous in: Illinois, 245; New York, 240; Ohio, 439; Pennsylvania, 299.

Thunderstorm days were most numerous in: Colorado, 28; Florida, 30; New York, 29; Ohio, 31; Tennessee, 27.

In Canada.—Thunderstorms were reported on the following dates: Halifax, 24; Grand Manan, 9, 30; Yarmouth, 24, 30; Chatham, 5, 6; Father Point, 10, 23; Quebec, 2, 7, 11, 15, 16, 21, 22, 23; Montreal, 1, 5, 11, 14, 16, 20, 23; Rockliffe, 5, 14, 19, 21, 23; Toronto, 11, 18, 22, 23, 30; White River, 9, 17, 26, 27, 30; Port Stanley, 11, 13, 14, 18, 25, 26, 30, 31; Saugeen, 18; Parry Sound, 11, 14, 20, 22; Port Arthur, 3, 4, 8, 9; Winnipeg, 2, 4, 5, 8, 18, 28, 29; Minnedosa, 5, 13, 17, 25; Qu'Appelle, 1, 3, 6; Medicine Hat, 10, 25; Swift Current, 5, 6, 8, 10, 21, 24; Calgary, 9; Prince Albert, 4, 30; Edmonton, 1, 17, 24, 30; Battleford, 6, 7, 21.

Auroras.—The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz, from the 9th to the 17th, inclusive. On the remaining twenty-two days of this month 123 reports were received, or an average of about 6 per day. The dates on which the number of reports of auroras for the whole country especially exceeded this average were: 21st, 51; 30th, 39.

Reports were most numerous in: Iowa, 11; Michigan, 22; Ohio, 17; Wisconsin, 19.

The number of reports was a large percentage of the number of observers in: Michigan, 20; Ohio, 13; South Carolina, 14; Wisconsin, 31.

In Canada.—Auroras were reported on the following dates: Halifax, 21; Charlottetown, 21; Father Point, 21, 26, 28, 29; Quebec, 21; Montreal, 21, 30; White River, 22; Saugeen, 20; Winnipeg, 6; Minnedosa, 29, 30; Medicine Hat, 18; Swift Current, 31; Prince Albert, 20, 21, 30.

CLIMATE AND CROP SERVICE.

By JAMES BERRY, Chief of Climate and Crop Service Division.

The following extracts relating to the general weather conditions in the several States and Territories are taken from the monthly reports of the respective sections of the Climate and Crop Service. The name of the section director is given after each summary.

Snowfall and rainfall are expressed in inches.

Alabama.—The mean temperature was 81.1°, or 0.6° above normal; the highest was 105°, at Decatur on the 3d, and the lowest, 50°, at Maple Grove on the 12th and 13th, and at Newburg on the 14th. The average precipitation was 4.78, or 0.38 below normal; the greatest monthly amount, 10.49, occurred at Newton, and the least, 0.56, at Clanton.—*F. P. Chaffee.*

Arizona.—The mean temperature was 82.4°, or 2.4° above normal; the highest was 118°, at Texas Hill; the lowest was 38°, at Fort Defiance on the 19th. The average precipitation was 1.62, or 0.42 above normal; the greatest monthly amount, 9.65, occurred at Benson, while none fell at Casa Grande.—*W. T. Blythe.*

Arkansas.—The mean temperature was 82.5°, or 2.3° above normal; the highest was 109°, at Keesees Ferry on the 30th and 31st, and the lowest, 50°, at Keesees Ferry on the 14th, and at Silver Springs on the 13th and 14th. The average precipitation was 3.25, or 0.66 below normal; the greatest monthly amount, 8.19, occurred at Moore, and the least, 0.65, at Washington.—*F. H. Clarke.*

California.—The mean temperature is obtained by dividing the State into equal areas, finding the mean of each square, and then dividing by the number of squares. The mean temperature was 74.5°, or 1.4 above normal; the highest was 124°, at Salton on the 22d. At Volcano Springs a temperature of 123° occurred on the 9th, while 120° occurred at Palm Springs, 118° at Ogilby, and 115° at Indio and Mammoth Tank; the lowest was 21°, at Bodie on the 6th and 22d, and at Nevada City on the 7th. The average precipitation was 0.01, or 0.04 below normal; the greatest monthly amount, 0.62, occurred at Descanso; at most places no rain fell.—*W. H. Hammon.*

Colorado.—The mean temperature was 65.5°, or 1.8° below normal; the highest was 109°, at Lamar on the 8th, and the lowest, 21°, at Walden, in North Park, on the 20th. Freezing temperatures occurred at a number of stations of moderate elevation on the 20th. The average precipitation was 2.05, or 0.15 below normal; the greatest monthly amount, 4.65, occurred at Minneapolis, and the least, 0.12, at Vilas. Snow fell at mountain stations on the 3d and 19th, the greatest amount reported being 10 inches at Ruby.—*F. H. Brandenburg.*

Florida.—The mean temperature was 82.1°, or slightly above normal; the highest was 102°, at Macclenny on the 1st and 2d, and the lowest, 60°, at Gainesville on the 15th. The average precipitation was 6.90, or 1.67 above normal; the greatest monthly amount, 14.82, occurred at Meyers, and the least, 2.19, at Pensacola.—*A. J. Mitchell.*

Georgia.—The mean temperature was 80.6°, or 0.2° below normal; the highest was 107°, at Leverett on the 3d, and the lowest, 46°, at Diamond on the 14th. The average precipitation was 5.74, or 0.58 above normal; the greatest monthly amount, 14.43, occurred at Gainesville, and the least, 1.15, at Cordele.—*J. B. Marbury.*

Idaho.—The mean temperature was 64.0°; the highest was 108°, at Minidoka on the 25th, and the lowest, 27°, at Lake on the 17th and at Martin and Swan Valley on the 19th. The average precipitation was 0.75; the greatest monthly amount, 2.43, occurred at Murray, and the least, trace, at Burnside and Martin.—*D. P. McCallum.*

Illinois.—The mean temperature was 77.0°, or 1.2° above normal; the highest was 106°, at Atwood on the 9th, and the lowest, 48°, at Scales Mound and Zion on the 13th. The average precipitation was 3.45, or 0.44 above normal; the greatest monthly amount, 7.85, occurred at Coatsburg, and the least, 0.93, at Jordans Grove.—*C. E. Linney.*

Indiana.—The mean temperature was 76.9°, or 2.1° above normal; the highest was 104°, at Kokomo on the 8th, and the lowest, 44°, at Hammond on the 13th. The average precipitation was 3.36, or 0.23 above normal; the greatest monthly amount, 9.09, occurred at Evansville, and the least, 0.74, at Hammond.—*C. F. R. Wappenhans.*

Iowa.—The mean temperature was 75.6°, or 1.6° above normal; the highest was 106°, at Malvern on the 23d, and the lowest, 42°, at Rockwell City on the 12th. The average precipitation was 3.26, or about 1.00 below normal; the greatest monthly amount, 7.60, occurred at Stuart, and the least, 1.01, at Osceola.—*G. M. Chappel.*

Kansas.—The mean temperature was 80.2°, or 1.9° above normal; the highest was 111°, at Wallace on the 6th, and the lowest, 45°, at Goodland on the 19th. The average precipitation was 3.13, or 0.60 below normal; the greatest monthly amount, 7.13, occurred at McPherson, and the least, 0.05, at Pratt.—*T. B. Jennings.*

Kentucky.—The mean temperature was 77.8°, or 1.5° above normal; the highest was 107°, at Pilot Oak on the 31st, and the lowest, 50°, at Eubank on the 14th. The average precipitation was 4.79, or 0.41 above normal; the greatest monthly amount, 9.05, occurred at Alpha, and the least, 0.82, at Ensor.—*Frank Burke.*

Louisiana.—The mean temperature was 83.1°, or 1.4° above normal; the highest was 104°, at Liberty Hill on the 6th, 25th, 26th, and 27th, and at Montgomery on the 26th; the lowest was 56°, at Oak Ridge on the 14th. The average precipitation was 3.83, or 1.79 below normal; the greatest monthly amount, 8.09, occurred at Amite, and the least, 0.44, at Robeline.—*R. E. Kerkam.*

Maryland and Delaware.—The mean temperature was 75.6°, or 0.5° above normal; the highest was 102°, at Westernport on the 3d, and the lowest, 41°, at Deer Park on the 14th. The average precipitation was 6.94, or 3.17 above normal; the greatest monthly amount, 19.90, occurred at Jewell, and the least, 2.78, at Cherryfields.—*F. J. Walz.*

Michigan.—The mean temperature was 72.1°, or 2.8° above normal; the highest was 104°, at Clinton on the 9th, and the lowest, 22°, at Humboldt on the 14th. The average precipitation was 3.23, or 1.00 above normal; the greatest monthly amount, 10.10, occurred at Bay City, and the least, 0.16, at Benton Harbor.—*C. F. Schneider.*

Minnesota.—The mean temperature was 71.5°, or 1.1° above normal; the highest was 102°, at Lawrence on the 18th, and the lowest, 38°, at Tower on the 28th. The average precipitation was 6.62, or 2.97 above normal; the greatest monthly amount, 12.81, occurred at Milaca and St. Cloud, and the least, 2.79, at Caledonia.—*T. S. Outram.*

Mississippi.—The mean temperature was 82.8°, or 1.5° above normal; the highest was 109°, at Columbus on the 3d and 4th, and the lowest, 52°, at Aberdeen on the 14th. The average precipitation was 4.42, or 0.58 above normal; the greatest monthly amount, 9.78, occurred at Leakesville, and the least, 0.95, at Hernando.—*R. J. Hyatt.*

Missouri.—The mean temperature was 78.8°, or 1.7° above normal; the highest was 106°, at New Madrid and Princeton on the 31st, and the lowest, 48°, at Ironton and Potosi on the 14th. The average pre-

cipitation was 3.40, or 0.51 below normal; the greatest monthly amount, 9.97, occurred at McCune Station, and the least, 0.60, at Emma.—*A. E. Hackett.*

Montana.—The mean temperature was 64.0°, or 4.0° below normal; the highest was 103°, at Fort Keogh on the 27th, and the lowest, 32°, at Castle on the 9th and at Kipp on the 18th. The average precipitation was 1.64, or 0.17 below normal; the greatest monthly amount, 3.24, occurred at Great Falls, and the least, 0.19, at Fort Keogh.—*R. M. Crawford.*

Nebraska.—The mean temperature was 75.9°, or 0.6° above normal; the highest was 112°, at Franklin on the 23d, and the lowest, 34°, at Camp Clark on the 10th. The average precipitation was 2.57, or 0.92 below normal; the greatest monthly amount, 7.44, occurred at Chester, and the least, 0.35, at Whitman.—*G. A. Loveland.*

Nevada.—The mean temperature was 69.4°, or 3.0° below normal; the highest was 116°, at St. Thomas on the 11th, 12th, and 27th; the lowest was 25°, at Hamilton on the 2d. The average precipitation was 0.27, or 0.01 above normal; the greatest monthly amount, 1.41, occurred at Palmetto, while no rain fell at several stations.—*R. F. Young.*

New England.—The mean temperature was 70.6°, or 1.1° above normal; the highest was 102°, at Plymouth, N. H., on the 5th, and the lowest, 40°, at Bar Harbor, Me., on the 19th, at West Milan, N. H., on the 27th, and at Flagstaff, Me., on the 28th. The history of the regular and voluntary observation service in New England furnishes no parallel to the precipitation record of this July. The extremes in the total falls of the month were 2.62 inches at Portland, Me., and 19.90 inches at Southington, Conn., a most remarkable variance considering the comparatively small area of this district.—*J. W. Smith.*

New Jersey.—The mean temperature was 74.1°, or 0.5° below normal; the highest was 100°, at Boonton, Dover, and Riverdale on the 10th, and the lowest, 50°, at Charlotteburg on the 16th. The average precipitation was 11.42, or 7.14 above normal; the greatest monthly amount, 20.80, occurred at Elizabeth, and the least, 6.11, at Camden.—*E. W. McGann.*

New Mexico.—The mean temperature was about 2.5° below normal; the highest was 104°, at Eddy on the 14th, and the lowest, 24°, at Winsors Ranch on the 20th. The greatest monthly precipitation, 5.60, occurred at Lower Penasco, and the least, 0.10, at Raton.—*H. B. Hersey.*

New York.—The mean temperature was 72.5°, or 2.5° above normal; the highest was 102°, at Avon on the 5th and 10th, and the lowest, 43°, at South Kortright on the 9th. The average precipitation was 6.69, or 3.02 above normal; the greatest monthly amount, 18.18, occurred at Setauket, and the least, 2.20, at Mount Morris.—*R. M. Hardinge.*

North Carolina.—The mean temperature was 77.2°, or 0.4° below normal; the highest was 103°, at Saxon on the 3d, and the lowest, 45°, at Highlands and Linville on the 15th. The average precipitation was 5.60, or normal; the greatest monthly amount, 11.11, occurred at Fayetteville, and the least, 2.07, at Sloan.—*C. F. von Herrmann.*

North Dakota.—The mean temperature was 68.9°, or 0.2° above normal; the highest was 109°, at Medora on the 28th, and the lowest, 38°, at Bordulac on the 4th. The average precipitation was 4.43, or 2.06 above normal; the greatest monthly amount, 8.94, occurred at Amenia, and the least, 0.33, at Glen Ullin.—*B. H. Bronson.*

Ohio.—The mean temperature was 75.5°, or 2.4° above normal; the highest was 113°, at Thurman on the 4th, and the lowest, 44°, at Levering on the 14th and 15th. The average precipitation was 4.65, or 1.09 above normal; the greatest monthly amount, 10.69, occurred at Ashtabula, and the least, 0.82, at Hedges.—*H. W. Richardson.*

Oklahoma.—The mean temperature was 82.4°; the highest was 110°, at Kingfisher and Winnview on the 14th, and the lowest, 48°, at Burnett on the 13th. The average precipitation was 2.05; the greatest monthly amount, 5.12, occurred at Beaver, and the least, 0.48, at Woodward.—*J. I. Widmeyer.*

Oregon.—The mean temperature was 63.7°, or 0.9° below normal; the highest was 107°, at Pendleton on the 11th, and the lowest, 28°, at Silver Lake on the 17th. The average precipitation was 0.58, or 0.12 above normal; the greatest monthly amount, 3.69, occurred at Bay City, while no rain fell at several stations.—*B. S. Pague.*

Pennsylvania.—The mean temperature was 73.4°, or 2.4° above normal; the highest was 103°, at Aqueduct on the 6th, and at Derry Station on the 5th and 6th, and the lowest, 41°, at Lock Haven on the 29th. The average precipitation was 6.26, or 2.11 above normal; the greatest monthly amounts were 14.51 at Saegerstown, 13.10 at Swiftwater, 12.42 at Forks of Neshaminy, 11.45 at Shawmont, 10.94 at Elwood Junction, and 10.25 at Philadelphia, Centennial Avenue; the least, 2.10, occurred at Cannonsburg.—*T. F. Townsend.*

South Carolina.—The mean temperature was 80.2°, or 0.4° above normal; the highest was 107°, at Batesburg on the 3d, and the lowest, 54° at Walhalla on the 15th. The average precipitation was 5.91, or 0.11 below normal; the greatest monthly amount, 9.81, occurred at St. Stephens, and the least, 2.99, at Spartansburg.—*J. W. Bauer.*

South Dakota.—The mean temperature was 72.8°, or about normal; the highest was 107°, at Ashcroft on the 28th, and the lowest, 35° at Ashcroft on the 20th. The average precipitation was 3.26, or 0.65 above normal; the greatest monthly amount, 7.27, occurred at Castlewood, and the least, 0.46, at Spearfish.—*S. W. Glenn.*

Tennessee.—The mean temperature was 77.7°, or 1.0° above normal; the highest was 105°, at Savannah on the 2d and at St. Joseph on the 2d and 3d, and the lowest, 46° at Erasmus on the 14th. The average precipitation was 5.09, or 0.46 above normal; the greatest monthly amount, 13.21, occurred at Oak Hill, and the least, 0.40, at Brownsville.—*H. C. Bate.*

Texas.—The mean temperature for the State was 1.6° above the normal. There was a general excess throughout the State except over the Panhandle and the mountainous portions of west Texas, where it ranged from the normal to 2.3° below. The greatest deficiency was at El Paso. The excess ranged from 0.2° to 3.5° over east and central Texas and the coast district, and from 1.2° to 3.9° over north and southwest Texas. The highest was 112°, at Waxahachie on the 26th, and the lowest, 48° at Mount Blanco on the 18th. The average precipitation for the State was 1.00 below the normal. There was a general deficiency throughout the State, except in the vicinity of Brenham and over north Texas, the Panhandle, the northern portion of central Texas, and the western portion of west Texas, where there was an excess ranging from 0.01 to 4.75, with the greatest in the vicinity of Gainesville. The deficiency ranged from 0.25 to 3.11 over east Texas, the southern portion of central Texas, and the eastern portion of west Texas, and from 0.54 to 5.21 over southwest Texas and the coast district, with the greatest deficit in the vicinity of Brazoria. Drought prevailed during the greater portion of the month. The rainfall was very poorly distributed over the State, there being comparatively no precipitation in many places, while there were good local showers at several places in north Texas. The greatest monthly amount, 7.32, occurred at Gainesville, while none fell at some stations.—*I. M. Cline.*

Utah.—The mean temperature was 68.7°; the highest was 110°, at St. George on the 11th, and at Mount Pleasant on the 12th, and the lowest, 23°, at Soldier Summit on the 18th. The average precipitation was 0.55; the greatest monthly amount, 1.70, occurred at Pahreah, and the least, 0.02, at Soldier Summit.—*J. H. Smith.*

Virginia.—The mean temperature was 76.4°, or 0.1° above normal; the highest was 100°, at Bon Air on the 3d, and at Woodstock on the 7th, and the lowest, 46°, at Big Stone Gap on the 14th. The average precipitation was 4.46, or 0.85 above normal; the greatest monthly amount, 7.70, occurred at Stanardsville, and the least, 1.70, at Bedford City.—*E. A. Evans.*

Washington.—The mean temperature was 62.4°, or 2.2° below normal; the highest was 107°, at Kennewick on the 11th, and the lowest, 32°, Cascade Tunnel on the 25th. The average precipitation was 1.39, or 0.72 above normal; the greatest monthly amount, 4.00, occurred at Snohomish, and the least, trace, at Fort Simcoe.—*G. N. Salisbury.*

West Virginia.—The mean temperature was 74.2°, or 3.0° above normal; the highest was 102°, at Point Pleasant on the 4th, and the lowest, 46°, at White Sulphur Springs on the 14th. The average precipitation was 5.43, or more than 1.00 above normal; the greatest monthly amount, 9.92, occurred at Beverly, and the least, 2.85, at Martinsburg.—*H. L. Ball.*

Wisconsin.—The mean temperature was 72.5°, or 2.0° below normal; the highest was 102°, at Prairie du Chien on the 8th, and the lowest, 41°, at Medford on the 13th. The average precipitation was 3.83, or 0.74 above normal; the greatest monthly amount, 15.11, occurred at Butternut, and the least, 1.20, at City Point.—*W. M. Wilson.*

Wyoming.—The mean temperature was 65.6°, or 2.0° below normal; the highest was 105°, at Lusk and Wamsutter on the 28th, and the lowest, 28°, at Atlantic City on the 3d. The average precipitation was 1.22, or 0.04 above normal; the greatest monthly amount, 3.77, occurred at Cheyenne, and the least, 0.03, at Wamsutter.—*M. F. Renoe.*

RIVER AND FLOOD SERVICE.

By PARK MORRILL, Forecast Official, in charge of River and Flood Service.

The highest and lowest water, mean stage, and monthly range at 114 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: Keokuk, St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

The following résumé of river stages and conditions of navi-

gation in the respective streams is compiled from reports by the officials of the Weather Bureau at various river stations and section centers:

Hudson River. (Reported by A. F. Sims, Albany, N. Y.)—During the first decade of July normal conditions obtained in the Hudson River and its tributaries. Heavy rains in the second decade sent all the rivers and creeks in this section beyond their natural confines. A heavy current was running in the Hudson River and boatmen experienced much difficulty in making their landings and in handling their craft. The passenger steamers and the towing lines when they tied up their boats on the night of the 14th put out extra hawsers to prevent them from being carried down stream. At 7:40 a. m. of the 15th the river was within 7 inches of the top of the dock at Albany; the highest point reached was 8.6 feet above mean low water. The river receded slowly during the 16th, and was about normal by 8 a. m. of the 18th. During the third decade of July the stage of the river remained slightly above the normal.

Susquehanna River and branches. (Reported by E. R. Demain, Harrisburg, Pa.)—The average rainfall within the drainage area of the river and its tributaries during the past month, as deduced from reports from sixteen river stations, was only 80 per cent of the average amount for July, 1896, and, as might be expected from such a deficiency, lower stages ruled in all the streams than during the corresponding period last year. The general rain which fell in Pennsylvania on the 27th and 28th was followed by the only freshet during the month, and caused rises in the various rivers and creeks, ranging from a fraction of a foot to 6 feet. The lowest waters occurred on the west branch; at Sinnemahoning and Cedar Run the water was below the zero of the gauge during the entire month, and at Cameron it was at zero during the greater part of the month. At Wilkesbarre, on the north branch, the gauge registered 1 foot below zero until the 28th, when it rose to zero, and on the 31st had risen to 5.0 feet above. At Harrisburg the river rose 2.7 feet from the 27th to 30th, the highest point touched being 4.5 feet on the 30th.

Rivers of South Atlantic States. (Reported by E. A. Evans, Richmond, Va.; C. F. von Herrmann, Raleigh, N. C.; L. N. Jesunofsky, Charleston, S. C.; D. Fisher, Augusta, Ga.; and J. B. Marbury, Atlanta, Ga.)—There were no changes of importance occurring in the James River at any time during the month. A uniform low stage of water was maintained, the range between the highest and lowest readings being only 0.9 foot. Rains were frequent over the watershed during the second decade of the month, but they were light and caused no rise worthy of mention. The water was clear from the 1st to 10th, and cloudy the remainder of the month.

Low river stages continued in all the rivers of North Carolina during the first half of July, notwithstanding the fact that the number of rainy days was large and the rainfall considerable. The rainfall was smallest over the basin of the Roanoke and tributaries, and only one 5-foot rise occurred in that stream (3d to 4th) to a stage of less than 10 feet on the gauge at Weldon. Over the Cape Fear Basin heavy rains caused a minor rise on the 14th, and a 20-foot rise in two days (20th to 22d) in the Cape Fear River at Fayetteville. Steamboat navigation on the lower courses of the streams was resumed the latter portion of the month; on the Cape Fear navigation has not been interrupted, steamers continuing to ply between Wilmington and Fayetteville the entire month.

Low but navigable water was maintained on all streams in South Carolina, except at Cheraw from the 1st to the 10th. The heavy rain between the 8th and 21st produced steady rises in the Waccamaw, Edisto, Lynch, Lumber, Black, the lower Pedee, and Santee rivers between the 11th and 31st. Navigation was interrupted at Cheraw from the 1st to the 8th and on the 30th and 31st. Excessive precipitation on the headwaters of the Wateree and Pedee in North Carolina during the 19th and 20th caused moderate freshets at Camden on the 21st and 22d and at Cheraw on the 22d and 23d.

The Savannah River remained at a moderately low stage, yet high enough for navigation, until the 20th, when, from the effects of hard showers in the upper basin, a rise of a little over 7 feet occurred at Augusta. The river, though shallow for the entire month, was less clear than is usual for low summer stages, a fact which river men are unable to explain. Navigation was continued during the month without interruption and the river boats were favored with fairly good cargoes. There were no decided changes in the other Georgia rivers, and they have averaged low during the entire month. The rains which have occurred have caused but slight and temporary rises.

Mobile River and branches. (Reported by F. P. Chaffee, Montgomery, Ala., and W. M. Dudley, Mobile, Ala.)—The water in the Alabama River and its tributaries continued low during the first decade, after which well-distributed rains over the watershed gave navigable stages. River traffic was resumed above Selma after the 12th, but all the streams were steadily falling again toward the close of the month.

The Tombigbee and branches were low at the opening of the month, being below the gauge zero at all stations, and continued falling until the 7th. There were heavy rains on the headwaters of the river during the early and middle parts of the month, which caused short rises. The greatest rise occurred on the 19th, when, at Tuscaloosa, the Tombigbee rose 9 feet in twenty-four hours. The rise continued to the 21st, when the river was over 15 feet above the zero of the gauge. The rise made the river navigable for coal barges which left Mobile and reached Tuscaloosa in safety. All rivers fell from the 22d to the end of the month, at which time navigation was somewhat threatened.

Ohio River and branches. (Reported by F. Ridgway, Pittsburg, Pa.; H. L. Ball, Parkersburg, W. Va.; S. S. Bassler, Cincinnati, Ohio; F. Burke, Louisville, Ky.; P. H. Smyth, Cairo, Ill.; L. M. Pindell, Chattanooga, Tenn.; and H. C. Bate, Nashville, Tenn.)—During the first three weeks of the month the upper Ohio continued at such a low stage that navigation was practically suspended. Rainfalls from the 17th to the 21st, however, caused an important rise which opened the river for packet navigation at Pittsburg during the remainder of the month. The wickets at Davis Island Dam were lowered on the 20th, and during the next four days 2,205,000 bushels of coal passed through the lock at that point bound for southern ports. During the last few days of the month the river fell steadily, and the month closed with barely sufficient water for packet navigation.

The rainfall over West Virginia was light during the first half of July and after the 3d all the rivers showed falling stages. Moderately heavy rains along the Great and Little Kanawhas on the 1st and 2d caused a slight rise, but this passed quickly. From the 11th to the close of the month rains were frequent and moderately heavy. The rivers rose slowly and most of them held good stages for navigation. At Parkersburg the largest packets were tied up for three weeks, but were released about the 20th and resumed business.

At Cincinnati river business was fairly active throughout the month. A small rise from the 3d to the 6th helped navigation materially during the period of low water. There was a good boating stage of water at Louisville during the entire month. The average depth was 6.4 feet, somewhat greater than the average for July.

At Cairo a good stage of water was maintained throughout the month. Combined rises out of the Cumberland, Tennessee, Ohio, and Mississippi gave Cairo a moderate rise, starting in on the 26th and continuing to the end of the month. River business during the month has been generally quiet, but this is not unusual at this season of the year.

For the sixth time since 1879 the Tennessee River has been navigable during the entire month of July. Heavy rains over the headwaters from the 2d to the 25th produced one of the best boating and logging tides for the month ever known. Reports on the 27th stated that the river had risen 16 feet at Charleston and was still rising; that the bottom lands were covered and the Hammond bottom, just across the river from Charleston, was covered up to the top of the tall corn. On July 28 reports from Clinton stated that the Clinch River was out of its banks, and that the Emory, French Broad, and Holston were at high water. The lumbermen of Chattanooga received news from the headwaters on the 27th that the Upper Clinch and Tennessee rivers had risen and a big log fleet had started down.

The month was unusually wet in the Cumberland Basin, and the river was held at a favorable stage for navigation in its upper divisions during the last half of the month, and in its lower divisions the entire month, and the month closed with the river open from Celina to its mouth.

Mississippi River and minor branches. (Reported by P. F. Lyons, St. Paul, Minn.; M. J. Wright, Jr., La Crosse, Wis.; G. E. Hunt, Davenport, Iowa; F. Z. Gosewisch, Keokuk, Iowa; H. C. Frankenfield, St. Louis, Mo.; P. H. Smyth, Cairo, Ill; S. C. Emery, Memphis, Tenn.; R. J. Hyatt, Vicksburg, Miss.; R. E. Kerkam, New Orleans, La.; and C. Davis, Shreveport, La.)—The month of July, 1897, was an eventful one inasmuch as there was not only a sufficiency of water in the Mississippi River to meet all the wants of navigation, but at the beginning of the second decade the water came within a few tenths of a foot of the danger line, or 14 feet on the gauge, at St. Paul; there was a daily average reading of 10.3 feet; the largest previous July average, determined from the last twenty-five years' record, was 7.6 feet, in 1874. The heavy and excessive rains over northern Minnesota during the early part of the month caused a continuous rise in the river ranging from 0.1 foot to 2.1 feet a day from the 1st to the 11th, when the maximum of 13.6 feet was registered; afterwards there was a gradual and almost steady fall to the end of the month, when the reading was 9.0 feet. Reports indicate that the Mississippi near its source was higher at the opening of this month than it was at any time last spring, and some loss to both crops and houses was reported from Aitkin County in consequence of overflow.

The average stage of water in the Mississippi River at La Crosse was higher than during any former year since the beginning of observations, and has materially interrupted the work of the Government engineers in this district. The gauge readings ranged from 7.3 to 10.5 feet. The water has been at an excellent stage for navigation. On several occasions the water has reached a maximum stage in July greater than was attained during the present month, but high water did not continue during the entire month as it did this year.

An excellent stage for navigation was maintained at Davenport during the entire month. The close of the month found the river somewhat higher than at the beginning. The rainfall was above normal from the head of the river to Reeds Landing. At La Crosse less than

half the normal precipitation occurred. At North McGregor and Dubuque it was slightly above, while from Le Claire to Muscatine it was somewhat below the normal. The river at Keokuk has continued at an unusually high stage for the month of July, with small range. The stage has been ample for navigation of the Des Moines Rapids for the largest steamboats and heaviest lumber or log rafts.

Exceptionally good boating stages were maintained throughout the month at St. Louis, but at the same time the tendency was downward, and at the end of the month there was from 6 to 8 feet less water than at the beginning. The lower cross levee at the head of the Indian Grave levee district broke on the 25th a short distance above Quincy, Ill. The break was occasioned by the overflow waters of Bear Creek after the heavy rains of the 24th and 25th. The break was about 1,000 feet in length, and the bottoms were flooded for a distance of 6 miles, causing considerable damage to the fields of ripening corn and other crops. From St. Louis to Cairo the river was falling during most of the month, but occasional rises kept the water at a good stage.

During the first four days of the month the river rose below Cairo from six to eight tenths of a foot daily, reaching the maximum stage of 18.3 feet, at Memphis, on the 4th. From that time the water fell steadily, reaching the minimum, 11.3 feet, on the 24th. During the last three days of the month the river rose 2.5 feet, bringing the reading up to 14 feet, which is considered a good stage for the end of July, and is 11 feet higher than was recorded on the same date in 1896. The month, as a whole, was exceptionally favorable for river navigation on the Mississippi and all navigable tributaries in this section, the water being generally higher than the average for July.

The rivers between Memphis and Vicksburg showed slight fluctuations during the month. Fair boatable water was maintained during the greater portion of the month and river traffic was good. The stage of water at Vicksburg was sufficient for small boats to land at the city front a portion of the month. Crops in the section recently overflowed have made remarkable growth and progress and with a late frost a good crop of cotton will be made on those lands. A moderately low stage of water continued in the Mississippi below Vicksburg during the entire month, the first ten days showing a rise of about 6 feet at Vicksburg, decreasing to less than a foot at New Orleans. After this there was a general decline to the close of the month.

During the first half of July, little or no precipitation fell in the watershed of the Red River, and decreasing stages were general. On several days during the latter half of the month liberal rains occurred and sharp rises characterized the stream, especially the upper portion. At Shreveport the stages were sufficient for navigation, the month opening with 9.3 feet on the gauge and closing with 6.0 feet.

Missouri River and branches. (Reported by L. A. Welsh, Omaha, Nebr., and P. Connor, Kansas City, Mo.)—There has been nothing unusual or noteworthy in the condition of the Missouri River during the month. The stage of water was somewhat variable during the earlier part of the month, but after that period the stage decreased slowly and steadily. The entire range of river stage during the month was only about 2.5 feet. The east bank of the Missouri River, directly opposite Plattsmouth, Nebr., is reported as cutting badly.

Arkansas River. (Reported by J. J. O'Donnell, Fort Smith, Ark., and F. H. Clarke, Little Rock, Ark.)—The upper Arkansas River continued low and was falling steadily to the 10th. On the morning of the 11th it had risen 2.0 feet to a stage of 5.0 feet, afterward falling slowly but steadily until the close of the month. Except between the 11th and 14th the river was below a navigable stage.

The lower Arkansas River maintained a uniform condition during the month. The average stage from Fort Smith to Little Rock was about 3.0 feet lower than for the corresponding month last year. Navigation was pursued uninterruptedly from Little Rock to the mouth, but the river was too low above Dardanelle to make navigation profitable on many days.

Heights of rivers above zeros of gauges, July, 1897.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.	Miles	Feet.	Feet.		Feet.		Feet.	Feet.
St. Paul, Minn.	1,957	14	13.6	11	6.5	1	10.3	7.1
Reeds Landing, Minn.	1,887	12	9.2	12-14	5.4	1	7.2	3.8
La Crosse, Wis.	1,822	10	10.5	17,18	7.3	2	8.7	3.2
North McGregor, Iowa	1,762	18	10.6	21,22	8.4	10	9.2	2.2
Dubuque, Iowa	1,702	15	10.2	24-27	8.3	5-7	9.1	1.9
Leclaire, Iowa	1,612	10	6.4	24-28	5.3	7-10	5.7	1.1
Davenport, Iowa	1,596	15	7.9	27,28	6.6	8-10,17	7.1	1.3
Keokuk, Iowa	1,466	14	7.8	26	6.0	13	6.8	1.8
Hannibal, Mo	1,405	17	9.8	26	7.2	13-15	8.0	2.6
Grafton, Ill	1,307	23	13.2	27,28	8.5	23	10.4	4.7
St. Louis, Mo.†	1,264	30	22.7	4	12.8	23	17.6	9.9
Chester, Ill.	1,189	30	16.8	5	9.4	25	12.8	7.4
Cairo, Ill	1,073	40	24.9	2	16.8	20,21	20.6	8.1
Memphis, Tenn	843	33	18.3	4,5	11.3	24	14.7	7.0
Helena, Ark	767	44	24.8	6-8	16.5	24-29	20.6	8.3
Arkansas City, Ark.	635	42	24.8	9,10	16.5	27-30	20.9	8.3
Greenville, Miss	595	40	20.3	9,10	13.4	29,30	17.1	6.9

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River—Cont'd	Miles.	Feet.	Feet.		Feet.		Feet.	Feet.
Vicksburg, Miss	474	41	24.0	12	15.2	31	20.3	8.8
New Orleans, La	108	16	7.1	10,11	4.5	29-31	6.2	2.6
Arkansas River.								
Fort Smith, Ark.	345	22	5.0	11	2.9	3	3.6	2.1
Dardanelle, Ark.	250	21	3.4	13	1.6	10	2.2	1.8
Little Rock, Ark.	170	23	5.8	24	4.0	11,12	4.8	1.8
White River.								
Newport, Ark	150	21	3.2	3	1.8	18-20	2.4	1.4
Illinois River.								
Peoria, Ill	135	14	9.1	1	4.9	30,31	6.5	4.2
Missouri River.								
Bismarck, N. Dak.	1,201	14	7.3	1,4	5.2	30,31	6.1	2.1
Pierre, S. Dak.	1,006	14	7.4	2,3	4.8	30,31	6.1	2.6
Sioux City, Iowa	676	19	11.5	7	8.4	31	10.1	3.1
Omaha, Nebr.	561	18	11.6	1	9.2	31	10.2	2.4
St. Joseph, Mo.	373	10	7.7	1	4.4	31	5.9	3.3
Kansas City, Mo.	280	21	18.0	2	9.8	28	13.7	8.2
Boonville, Mo.	191	20	16.5	8	9.2	31	12.3	7.3
Hermann, Mo.	95	21	13.5	3	4.9	30,31	8.5	8.6
Ohio River.								
Pittsburg, Pa	966	22	8.1	24	4.3	6	5.9	3.8
Davis Island Dam, Pa.	960	25	9.4	24	2.6	2,3	4.9	6.8
Wheeling, W. Va.	875	36	13.8	24	2.8	3-5	5.9	11.0
Parkersburg, W. Va.	785	35	13.5	25,27	5.0	11	8.2	8.5
Point Pleasant, W. Va.	703	36	17.5	26	3.8	12	8.7	13.7
Catlettsburg, Ky	651	50	23.2	26	5.2	1	11.4	18.0
Portsmouth, Ohio	612	50	23.0	26,27	7.0	1	12.4	16.0
Cincinnati, Ohio	499	45	24.8	28	9.1	3	13.9	15.7
Louisville, Ky.	367	24	9.3	28,29	4.9	4	6.4	4.4
Evansville, Ind	184	30	17.4	31	6.5	7	9.4	10.9
Paducah, Ky.	47	40	14.7	31	6.3	19,20	9.3	8.4
Alleghany River.								
Warren, Pa	177	7	1.1	7,25	0.0	1-6	0.5	1.1
Oil City, Pa	123	13	2.7	20,25	0.4	7	1.5	2.3
Parkers Landing, Pa.	73	20	4.5	23	0.6	8	2.0	3.9
Freeport, Pa.	26	20	8.0	23	1.2	8	3.6	6.8
Conemaugh River.								
Johnstown, Pa.	64	7	2.8	22,28	0.8	5	1.6	2.0
Red Bank Creek.								
Brookville, Pa.	35	8	2.2	21	— 0.9	1-11	0.2	3.1
Beaver River.								
Ellwood Junction, Pa.	10	14	5.8	23	— 0.2	4,5	1.4	6.0
Cumberland River.								
Burnside, Ky	434	50	8.7	17	1.3	5	3.9	7.4
Carthage, Tenn	257	30	12.6	26	2.1	3	5.6	10.5
Nashville, Tenn	175	40	15.6	27	3.4	4,7	7.6	12.2
Great Kanawha River.								
Charleston, W. Va.	61	30	13.4	3	4.8	11	6.3	8.6
New River.								
Hinton, W. Va.	95	14	4.0	24	1.5	18	2.3	2.5
Licking River.								
Falmouth, Ky.	30	25	5.0	27	1.5	17	2.4	3.5
Miami River.								
Dayton, Ohio	69	18	5.0	22	1.2	14,16	1.9	3.8
Monongahela River.								
Fairmont, W. Va	119	25	6.1	23	0.4	1,2	2.0	5.7
Greensboro, Pa.	81	18	10.3	23	7.1	1,2	8.3	3.2
Lock No. 4, Pa.	40	28	12.0	24	6.4	1,2	8.6	5.6
Cheat River.								
Rowlesburg, W. Va.	36	14	5.0	27	2.0	1,2,12	3.2	3.0
Youghiogheny River.								
Confluence, Pa.	59	10	2.4	23	0.4	6,7	1.0	2.0
West Newton, Pa.	15	23	1.5	21	0.0	15-18	0.4	1.5
Muskingum River.								
Zanesville, Ohio	70	20	9.2	24	5.5	6,10	6.8	3.7
Tennessee River.								
Knoxville, Tenn	614	29	3.0	12,13	2.2	6,10,29	2.5	0.8
Kingston, Tenn	534	25	7.2	26	1.3	15,16	2.6	5.9
Chattanooga, Tenn	430	33	13.3	27	3.4	4,5	5.5	9.9
Bridgeport, Ala	390	24	9.9	27	1.7	5	3.7	8.2
Florence, Ala	230	16	7.7	29	1.7	7	3.3	6.0
Johnsonville, Tenn	94	21	9.5	31	3.3	9-12	4.8	6.2
Clinch River.								
Speers Ferry, Va.	156	20	7.4	22	0.2	5,6,19	1.2	7.2
Clinton, Tenn	46	25	12.5	23	3.6	4	5.6	8.9
Wabash River.								
Mount Carmel, Ill	50	15	4.3	1	2.8	22-25	3.2	1.5
Red River.								
Arthur City, Tex.	688	27	13.4	23	3.6	8	7.0	9.8
Fulton, Ark	565	28	11.4	27	3.9	20-22	5.9	7.5
Shreveport, La.	449	29	9.3	1	2.7	25-27	4.9	6.6
Alexandria, La	139	33	9.3	1	0.5	31	3.5	8.8
Atchafalaya Bayou.								
Melville, La.	100*	31	22.5	1	14.8	31	20.1	7.7
Ouachita River.								
Camden, Ark.	340	39	5.3	23	3.2	15-18	3.9	2.1
Monroe, La	100	40	7.5	1	1.3	17,18	2.4	6.2
Yazoo River.								
Yazoo City, Miss.	80	25	2.5	25,26	— 0.1	7	0.9	2.6
Chattahoochee River.								
Columbus, Ga.	140	20	11.0	22	0.6	19	3.2	10.4
Flint River.								
Albany, Ga.	80	20	5.7	9	1.0	4,5	3.1	4.7
Cape Fear River.								
Fayetteville, N.C.	100	38	25.3	22	1.9	6	6.5	23.4
Columbia River.								
Umatilla, Oreg	270	16	16.9	5,6	10.6	31	14.3	6.3
The Dalles, Oreg	166	40	27.5	6	16.7	31	23.2	10.8
Willamette River.								
Albany, Oreg	99	20	3.4	1	1.3	31	2.2	2.1
Portland, Oreg	10	15	14.9	1,7	8.4	31	12.4	6.5
Edisto River.								
Edisto, S. C	75	6	5.1	29	1.7	9,10	3.0	3.4

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger-line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
James River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Lynchburg, Va.	257	18	1.9	23	0.1	17-19	0.6	1.8
Richmond, Va.	110	12	0.7	24	− 0.2	2, 9, 10, 12	0.2	0.9
Alabama River.								
Montgomery, Ala	265	35	8.4	24	0.5	2	2.8	7.9
Selma, Ala	212	35	9.8	25	0.5	3	3.3	9.3
Coosa River.								
Gadsden, Ala	144	18	10.1	22	0.0	1	2.6	10.1
Tombigbee River.								
Columbus, Miss	285	33	− 0.2	17	− 3.0	31	−2.3	2.8
Demopolis, Ala	155	35	8.2	23	− 1.5	2-6	1.2	9.7
Black Warrior River.								
Tuscaloosa, Ala	90	38	14.5	21	− 0.2	2-4	3.4	14.7
Pedee River.								
Cheraw, S. C	145	27	20.4	23	2.0	31	5.4	18.4
Black River.								
Kingstree, S. C	60	12	3.7	30, 31	1.3	11-13	2.5	2.4
Lumber River.								
Fair Bluff, N. C	10	6	5.1	31	− 0.4	9	1.7	5.5
Lynch Creek.								
Effingham, S. C	35	12	12.1	29	2.5	7,8	5.2	9.6
Potomac River.								
Harpers Ferry, W. Va.	170	16	2.0	28	0.1	19	1.1	1.9
Roanoke River.								
Clarksville, Va	155	12	......	......	......	......	......	......

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Sacramento River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Red Bluff, Cal	241	23	1.0	1-5	0.1	23-31	0.5	0.9
Sacramento, Cal	70	25	13.8	1	10.0	31	11.6	3.8
Santee River.								
St. Stephens, S. C	50	12	7.3	28-31	2.6	7	5.3	4.7
Congaree River.								
Columbia, S. C	37	15	3.5	21, 22	1.5	1-13, 15-19, 24-31	1.7	2.0
Wateree River.								
Camden, S. C	45	24	22.5	22	4.0	2-4, 8	7.4	18.5
Savannah River.								
Augusta, Ga	130	32	16.6	20	5.7	17	8.5	10.9
Susquehanna River.								
Wilkesbarre, Pa.	178	14	5.0	31	− 1.0	1-27	−0.5	6.0
Harrisburg, Pa.	70	17	4.5	30	1.0	13, 15, 16	1.6	3.5
Juniata River.								
Huntingdon, Pa	80	24	4.0	19, 28, 29	2.8	10-18	3.1	1.2
W. Br. of Susquehanna.								
Williamsport, Pa	35	20	4.8	30	0.7	6-9	1.5	4.1
Waccamaw River.								
Conway, S. C	40	7	2.2	7, 30	0.6	26	1.6	1.6

*Distance to the Gulf of Mexico. † Record for 28 days

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THE OBSERVATION OF HALO PHENOMENA.[1]

(Translated from a separate print from the annual volume of the Natural History Association of Wurtemberg. Communicated by Rev. K. Schipps; dated Feb., 1897.)

The light from the sun, moon, and brighter stars, by means of refraction through or reflection on ice crystals—when the latter occur in great numbers, in definite positions, over a considerable region—manifests itself in figures of manifold forms, known as halo phenomena. These are very seldom observed in crystals of ice that lie upon the surface of the earth; more frequently, but still rarely, in those crystals that float in the atmosphere in the immediate neighborhood of the observer so that, for instance, they rarely develop between the observer and any distant object. As a rule, and, indeed, by no means so rarely as is ordinarily thought, halos occur in the clouds or haze of ice crystals at different altitudes in the atmosphere, but above the observer's head. The most frequent form of halo is a circle around the star whose light produces it, having a radius of about 23°; that is to say, the line from the eye to the star makes an angle of about 22° to 23° with the line from the eye to the circle. The circle shows the colors of the rainbow, beginning with red on the inside of the circle (in contrast to the rainbow, where the red is on the

[1] The Chief of the Weather Bureau has just received from Rev. K. Schipps, of Baustetten, near Laupheim, Wurtemberg, Germany, a letter requesting the cooperation of those interested in the study of halos. A committee for this purpose has been formed in Germany, on behalf of which Mr. Schipps has issued a circular, which we translate herewith, and which will be found instructive as a guide to both observers and students.

convex side). Most frequently we observe only the red on the concave side, but next frequently, also, a blue tint on the convex side. The circle has about the same breadth as that of the moon. The inner edge, viz, that turned toward the star, is without exception more sharply defined than the outer edge; the region between the halo and the star is peculiarly free from light, and almost always appears considerably darker than the area outside of the circle. The halo, like all forms of this phenomenon, is generally developed only in fragments, with a special preference for the upper region; that is to say, on the side nearer the zenith. Next in frequency after the halo are the mock suns, parhelia, and mock moons, which occur either in pairs or individually at the same altitude as the sun or moon and at the same distance, viz, about 23°, from it; therefore, approximately, lying on the circle just mentioned, generally not sharply defined and ordinarily of a deep purple red, especially on the side toward the luminary.

Concentric with the first-mentioned circle, there sometimes forms a larger one, with a radius of about 46°. Through the sun, parallel to the horizon, and therefore having its center in the zenith, there passes the white "parhelic circle," with two, four, or six mock suns. Ordinarily this parhelic circle is well developed only in the neighborhood of the first halo circle and the mock suns. Through the sun, perpendicular to the horizon, there is, also, a whitish band, called the "vertical column of light." Not infrequently there occurs in the upper part of the circle around the star a "tangential arc," located symmetrically to the vertical column of light, like a fragment of a circle of larger or smaller radius than the existing halo. Besides these many other forms occasionally occur (several dozen have been recorded), the individual description of which would lead us too far.

Halo phenomena have been very rarely observed about the brighter stars. Those around the moon are most frequent and easiest to see. Those of the greatest absolute frequency are the solar halos, but these are generally difficult to observe on account of the more intense sunlight and are overlooked, especially because they generally occur only in fragments.

Solar halos can, with advantage, be observed according to a method practiced in the earliest times by their reflection in water, or by reflection from smoked glass. But the observer should practice the direct observation of the sky. To this end, one may place himself in the shadow of a house or the thick foliage of a tree so that the direct sunlight is cut off. One will soon acquire so much experience that the hand or any other object held in front will suffice to cut off the sun's rays. It is best to first examine a region of the sky lying farther from the sun by the use of the above-mentioned primitive screens, and then by slow motion approach the region that is to be observed. A good eye possesses such a power of accommodation that it gradually becomes able to do without this assistance, at least for short intervals of time; still, care should be taken to preserve the eye from harm.

If a halo phenomenon is observed it should be immediately and accurately described so that the individual phases of the phenomenon should not be confounded. The description should include the name of the observer and of the locality, the time and the duration, expressed in central European standard time (one hour east of Greenwich[1]). The form of the phenomenon is quickest and safest described by means of a simple drawing, which is best made by considering the top of the drawing as corresponding to the zenith. In the description, which should be as brief as possible, the ordinary phenomena can be described by simply using the name of the form. The orientation or location of the details with respect to the sun or moon can ordinarily be given by using the letter *a* for above, *b* for below, *r* right hand, as seen by the observer, *l* left hand; *ra* for the region on the right hand and above the altitude of the sun; *rb* for the right hand and below; *la* left hand and above; *lb* left hand and below. The intensity, the location and order of sequence of the colors, as well as the general intensity of the light, in the several parts of the halo, should also be given. For this purpose the ordinary three scale, 0, 1, 2, is sufficient, but the 1 may be omitted, so that feeble, or intense, optical phenomena can be briefly sketched by writing the superscript 0, or 2, to the right hand of the letter I for intensity, so that I^0 designates feeble intensity and I^2 designates very intense. In a similar way the nature of the boundary of the circle can be noted by using B for boundary and indicating by Bi the inner or concave and Be the exterior or convex side, to which the superscript 0 or 2 may be added for indefinite or very sharp edges, respectively; thus, Bi^2=boundary of the side of the circle on the side toward the sun sharply defined, or Ba^0= boundary of the outer rim of the circle ill defined.

The symbol used in meteorology for all forms of these phenomena is, for solar halos, the well-known solar wheel ⊕ of the ancient mythology. For lunar halos the upper half only of this same wheel ⏀ is used.

After some experience one will be able to decide quickly on the first glance at the sky whether or not a halo is to be expected within a given time, whereby on the one hand much time is saved, and on the other hand more phenomena are observed. When the cloudiness is favorable for the formation of halos one can not examine the sky too often on account of the rapid changes of the individual forms with location and with time. When the sky is covered only with cumulus clouds, in a state of rapid change of form and very sensitive to the influence of the solar radiation and through which the sun appears as a disk, it is certain that no halo will be formed. On the other hand if the sky is covered with small cirrus clouds, or little wool flecks, which in certain places thin out into grayish white streaks of perfectly homogeneous structure, or show themselves fantastically intertwined and drawn out as homogeneous shreds of clouds of small dimensions, as cats' tails, or such bands as radiating from one point pass over the whole sky, namely, polar bands, then certainly either a halo, or at least a fragment of a halo, or individual "mock suns" are to be expected. If these stripes broaden out and gradually cover the whole sky while at the same time the barometer falls, then more enduring, more complete, and often very complex forms of the phenomena are to be expected, until gradually the veil of clouds attains a dark gray black appearance and grows thicker, so that the sun is seen through it only as a bright spot without a definite border. From this time on a disappearance of the phenomena is again to be expected.

Whoever is in possession of the proper instruments should not neglect to take measurements of the angular distances of the phenomena from the sun. In doing this it is advisable not to stop with one measurement of the individual phenomena, but to take many of them in rapid succession, and furthermore to again undertake new measurements after the lapse of a considerable interval. From a morphological point of view (viz, the description of the forms) the halo phenomena have been rather thoroughly studied and observed. On the other hand, there is still wanting a long continued series of measurements, especially for our latitudes, in order to understand the changes that are going on.

Moreover, notwithstanding the extended network of meteorological stations, there are still wanting simultaneous observations over a large region since, as it would appear, meteorological optics as yet receives no great attention on the part of observers, except in Japan. But it is precisely these ob-

[1] The observers of the United States Weather Bureau will, of course, use eastern or seventy-fifth meridian standard time.

servations that would be of value for the furtherance of our knowledge as to the clouds of ice crystals in front of the whirlwind or as to the local similar and simultaneous formation of ice in the atmosphere.

Even the individuality of the observer has an influence upon the minute details of observations that is of an importance not to be underestimated, and, therefore, every observer should seek to understand the errors to which he is personally liable, and the times at which he is in the best personal condition. This has a special bearing on the perception and distinction between colors. To one person great differences of intensity will alone affect his consciousness, whereas another has the power of distinguishing the finest shades; therefore, a note upon the individual colors that are observed and their succession from the inside to the outside of the halo should not be neglected. Not less important is the difference in the observation of the blue tints on the outer side of the circle, since one observer can observe violet only in a narrow zone, whereas another can follow it throughout a wider band.

In conclusion the subscriber invites all who have sufficient leisure and love of nature to join in the minutest observations of halo phenomena, and to kindly send him the results, since the greatest usefulness is to be expected from the discussion of all the material from a single point of view, and since, moreover, individual observations are easily scattered and lost.

THE EQUATIONS OF HYDRODYNAMICS IN A FORM SUITABLE FOR APPLICATION TO PROBLEMS CONNECTED WITH THE MOVEMENTS OF THE EARTH'S ATMOSPHERE.

By JOSEPH COTTIER, Columbia University, N. Y. (dated June 29, 1897).

Introductory note.—The equations of fluid motion as usually given in terms of rectangular coordinates are unsuitable for use in problems connected with the motions of fluids on the earth's surface, owing to the curved surface of the latter. Hence, either the Cartesian equations must be transformed into the equations for polar coordinates, by purely mathematical considerations, or an independent deduction of the equations in terms of polar coordinates must be made. The former course was adopted by Mr. Basset[1] in obtaining the equations of an incompressible fluid in terms of polar coordinates; the latter process is that adopted in this paper, longer and more laborious perhaps, but having the advantage of giving a clearer conception of the terms entering the final equations and of the intermediate steps.

The plan of this article follows closely that of a paper read by the writer before the American Mathematical Society,[2] adapted to the simpler polar coordinates. Since it is hoped this latter paper will soon be published, many of the more complex reductions therein have been dismissed with a mere reference, as being unnecessary to a comprehension of the equations and methods here employed.

General considerations.—The earth is a slightly ellipsoidal body, whose mean radius is about 3,959 miles, or 6,371 kilometers; the polar diameter is, roughly, only one three-hundredth part shorter than the mean equatorial diameter, so that all necessary accuracy will be obtained by considering the surface of the earth as a sphere of the above radius.

The coordinate system suitable for rotating spherical surfaces, or for surfaces departing but little from the spherical form, is, of course, the well-known "polar coordinate" system, where the coordinates determining the position of a point are its north polar distance (θ), its rotation angle measured eastward (λ), and its distance from the center of the earth (r). The measurement of geographic longitude positive westward is determined by the fact of the eastward rotation of the earth in space.

The equations of motion which it is desired to obtain are three equations, which for three separate orthogonal directions express the equality of the "expressed force" of a fluid particle to the sum of the "impressed forces" and of the resultant surface traction on the particle in the same direction.

The "expressed force" of a particle is the force necessary to produce the existent acceleration in the given direction, and is equal to the product of the mass of the particle and of that acceleration.

The "impressed forces" are those forces which are applied individually to each particle of the fluid, such as gravitational forces, electrical forces, etc. The only impressed force which need be taken into account in connection with atmospheric disturbances is the gravitational attraction of the earth, whose value per unit mass in any direction may be expressed as the derivative in that direction of the Newtonian potential, F. It may be considered that the derivatives of F with respect to θ and λ, that is to say, parallel to the surface of the earth, are each zero.

The surface tractions are due in part to the "fluid pressure," constant in all directions at a given point and independent of the viscosity of the fluid, and in part to the internal friction of the fluid determined by the relative motions of its particles.

In all material fluids the internal friction or viscosity can not change the mean normal pressure, or the fluid pressure at any point, but it does cause a tangential resistance, or "shearing stress," between layers of particles which are in relative motion. It is generally assumed, and the assumption is borne out by experience, that the shearing stress at any point and parallel to any plane, is proportional to the rate at which the velocity parallel to the plane is varying in a direction normal to that plane, that is to say, viscosity is proportional to that component of the relative motion of the particles that is parallel to that plane, or to the rate of "shearing stress" upon it. A finite slip between the fluid and the surfaces with which it may be in contact, or between contiguous layers of the fluid itself, or between the layers at the limiting surface that is technically known as a "surface of discontinuity," would thus mean an infinite shearing stress parallel to the surface of discontinuity, and is hence precluded.

The coefficient of friction expresses the ratio between the shearing stress and the shearing strain; it may be defined conveniently as the difference of the tangential tractions per unit area on two very large and parallel planes at the unit distance apart, moving in the same direction with the unit difference of velocity. The space between these parallel planes being filled with the fluid, the velocity gradient in a direction normal to the slower moving plane will be unity, and therefore, according to definition, the intensity of the tangential stress on that plane due to viscosity, will be numerically equal to the coefficient of viscosity, which by common consent is denoted by the Greek letter μ. The coefficient of viscosity is, approximately, proportional directly to the absolute temperature of the air, and is independent of the pressure.[1] As nearly as present experimental data permit of its estimation, the value of the coefficient of viscosity at a temperature of 62° F., in terms of British units,[2] may be considered as being:

[1] Treatise on Hydrodynamics. Vol. II. §470.

[2] "On the Expression of the General Equations of Hydrodynamics in Terms of Curvilinear Coordinates," read before the American Mathematical Society, March 27, 1897, and about to be published in The Mathematical Review.

[1] Maxwell, Phil. Trans., 1863.

[2] The British units referred to are the foot and mean solar second as units of length and time, and the mass of a pound of matter as the unit of mass. The unit of force, or "poundal," is the force which, acting on a unit mass, produces unit acceleration.

$$\mu = 0.0000125 \text{ lbs.} / \text{ft. sec.},$$

or, in the C. G. S. system,

$$\mu = 0.000185 \text{ gr.} / \text{cm. sec.}$$

From the nature of μ it will be seen that its dimensions are $M^{+1} L^{-1} T^{-1}$.

The equations of motion are applied to, and the coefficient of friction is defined for, either so-called steady motion or motion varying according to some definite law; whereas the atmosphere is in a constant state of commotion and of irregular movement. M. Boussinesq[1] has shown that in the case of turbulent motion the general equations of the mean motion take the same forms as the equations for steady or regularly varying motion, provided the coefficient of friction be considered variable and dependent upon the local turbulence of the movement. If the gusty character of the atmosphere be quite universally and uniformly distributed, it may be presumed that a sufficient allowance for it may be made by slightly increasing the value of μ.

Kinematical considerations.—It is usual among meteorologists to define the motion of an atmospheric particle by the three components of the velocity, counted positively southward, eastward, and zenithward, denoted by u, v, and w, respectively. The spacial displacements measured from a given point in these directions are similarly denoted by x, y, and z. These symbols will be adhered to as far as possible in this paper. These velocity components are derived quantities, being connected with the space-rates of variation of the coordinates by the equations:

$$u = r\, d\,\theta/dt \ldots\ldots\ldots\ldots \text{(southward)}.$$
$$v = r \sin\theta\, d\,\lambda/dt \ldots\ldots \text{(eastward)}.$$
$$w = dr/dt \ldots\ldots\ldots\ldots \text{(zenithward)}.$$

It will be noted that the terms "southward," "eastward," "zenithward" only have a definite meaning when the position of the particle on the terrestrial sphere is specified. They mean different absolute directions for any particles not on the same radius.

All the kinematical quantities at present sought may be made to literally drop into our hands from the following simple fiction: Let two auxiliary systems of Cartesian (rectangular and rectilinear) axes be chosen; let the one system, XYZ (identical with that previously mentioned if the rotation of the earth be neglected), be fixed in space and coincident respectively with the southward, eastward, and zenithward directions at the position P_0 occupied by the centroid of a particle at a given time $t=t_0$; let the second system, $X_1Y_1Z_1$, also have its origin fixed in space at P_0. If then to this second system, which may be supposed to have directional freedom, there be imparted constant angular velocities

$$\omega_1 = -v/r\,; \quad \omega_2 = +u/r\,; \quad \omega_3 = +v/r \cot\theta,$$

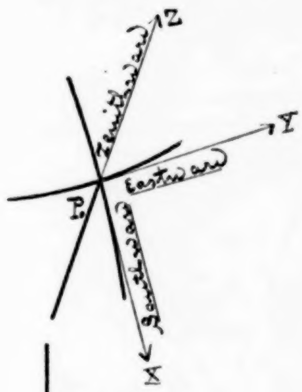
counted positive in the cyclic directions (left-handed), these moving axes will, for a small interval of time immediately preceding or following the given instant, remain parallel to the southward, eastward, and zenithward directions corresponding to the position P occupied by the centroid of the particle at the time t. It is assumed that at the given instant P is moving away from the position P_0, at a velocity whose components resolved along X, Y, and Z are u, v, and w, respectively. (See Fig. 1.)

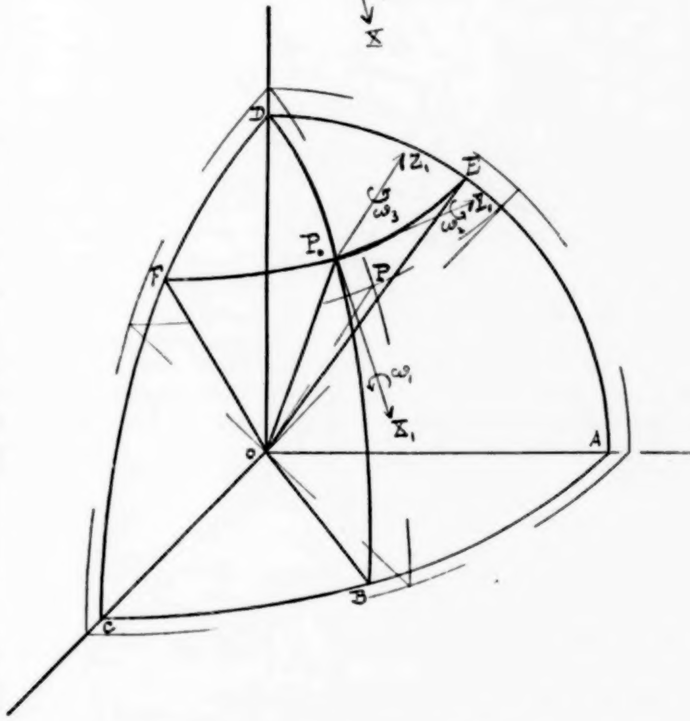
It is convenient to use the Newtonian notation, $\dot{x}$, $\dot{y}$, $\dot{z}$, for the components of the absolute velocity of a point, and $\ddot{x}$, $\ddot{y}$, $\ddot{z}$, for the components of its absolute acceleration, referred to the fixed Cartesian system, XYZ, with a similar notation for the relative velocity and acceleration with respect to the moving system, $X_1Y_1Z_1$. Since these two systems of axes coincide at the initial instant, the ordinary laws of relative motion show that

$$\dot{x} = \dot{x}_1 - y_1\omega_3 + z_1\omega_2$$
$$\dot{y} = \dot{y}_1 - z_1\omega_1 + x_1\omega_3$$
$$\dot{z} = \dot{z}_1 - x_1\omega_2 + y_1\omega_1$$

and remembering that the angular velocities of the secondary system are constant, upon differentiation with respect to the time,

$$\ddot{x} = \ddot{x}_1 - \dot{y}_1\omega_3 + \dot{z}_1\omega_2$$
$$\ddot{y} = \ddot{y}_1 - \dot{z}_1\omega_1 + \dot{x}_1\omega_3$$
$$\ddot{z} = \ddot{z}_1 - \dot{x}_1\omega_2 + \dot{y}_1\omega_1$$





EP₀F-O is cone θ = const.
DP₀B-O is plane λ = const.
ABC-D is sphere r = const.
} for P₀.

FIG. 1.

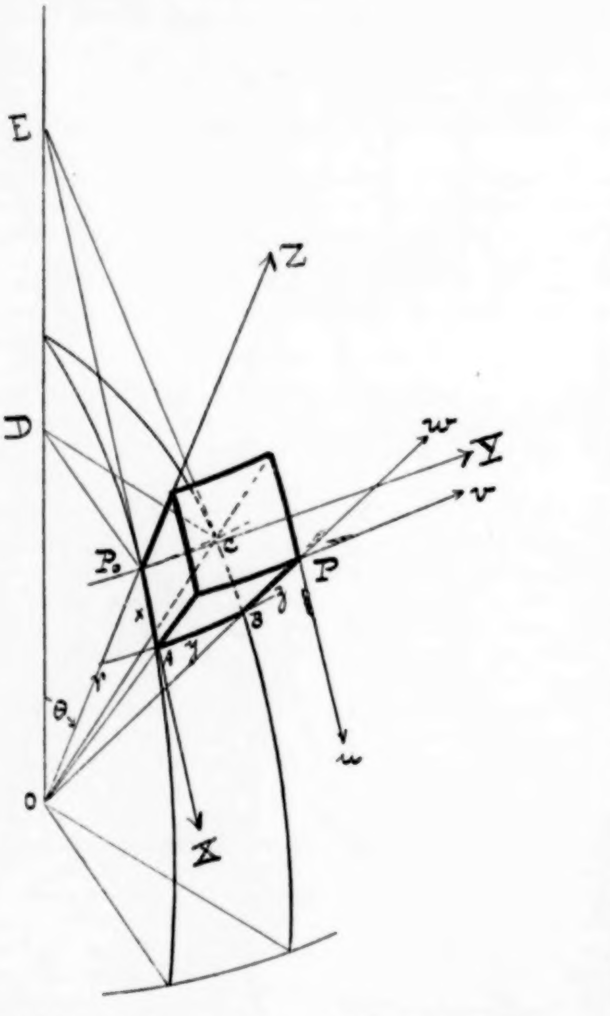
Another set of values may be obtained for the velocities in terms of the primary system X,Y,Z. Let u, v, and w be the velocity-components, and x, y, and z the coordinates, of any one of the cluster of points surrounding the origin P_0, of the two auxiliary systems of Cartesian axes, and let θ, λ, r, be the polar coordinates, with reference to the center and axis of

[1] "Essai sur la theorie des eaux courantes," 1872, part I, §§ 1 and 2, pp., 24–26. Memoires des Savans Etrangers. Tome XXIII. Paris, 1877.

the earth, of this same origin P_0, which now becomes the position of the centroid of the given particle at the time $t=t_0$. It will be supposed that x, y, z are each so small that their squares and products may be neglected. Then resolving u, v, and w parallel to the three axes X, Y, and Z, it will be found that

$$
\begin{aligned}
\dot{x} &= u + wx/r - vy/r \cot\theta \\
\dot{y} &= v + wy/r + uy/r \cot\theta \qquad (1) \\
\dot{z} &= w - vy/r - ux/r
\end{aligned}
$$

The verification of these equations is easiest made by comparison with Fig. 2, where the magnitudes of the various angles are indicated.



$P =$ point (x, y, z); $P_0A = x$; $AB = y$; $BP = z$.

$$
\left.\begin{aligned}
\text{Angle } P_0OA &= \frac{x}{r} \\
\text{Angle } AOB &= \frac{y}{r}
\end{aligned}\right\}
\qquad
\left.\begin{aligned}
\text{Angle } P_0DC &= \frac{y}{r\sin\theta} \\
\text{Angle } P_0EA &= \frac{y}{r}\cot\theta
\end{aligned}\right\}
$$

FIG. 2.

Thus, at P_0, where $x = y = z = 0$, and $x_1 = y_1 = z_1 = 0$,

$$\dot{x}_1 = \dot{x} = u \ ; \quad \dot{y}_1 = \dot{y} = v \ ; \quad \dot{z}_1 = \dot{z} = w,$$

and $\ddot{x}_1$, $\ddot{y}_1$, $\ddot{z}_1$ are the time rates of variation of these same quantities with respect to the moving system, or to the polar coordinate system, for the angular velocities imparted to the moving axes were such as to make these remain parallel to the directions in which the polar velocities are measured for a small interval of time near the given instant $t = t_0$. Now, in a small time δt, the centroid of the particle, moves from (θ, λ, r) a distance $w\delta t$ toward the zenith, and changes its angular position by $u/r \cdot \delta t$ southward along the meridian, and by $\dfrac{v}{r\sin\theta}\delta t$ eastward along a parallel. Hence, for example,

$$\delta u = \frac{\partial u}{\partial\theta}\cdot\frac{u}{r}\delta t + \frac{\partial u}{\partial\lambda}\cdot\frac{v}{r\sin\theta}\delta t + \frac{\partial u}{\partial r}\cdot w\,\delta t + \frac{\partial u}{\partial t}\cdot\delta t$$

and
$$\ddot{x}_1 = \frac{\delta u}{\delta t} = \frac{\partial u}{\partial\theta}\cdot\frac{u}{r} + \frac{\partial u}{\partial\lambda}\cdot\frac{v}{r\sin\theta} + \frac{\partial u}{\partial r}\cdot w + \frac{\partial u}{\partial t}$$

But at the origin,

$$
\begin{aligned}
\frac{\partial}{\partial x} &= \frac{1}{r}\frac{\partial}{\partial\theta} \\
\frac{\partial}{\partial y} &= \frac{1}{r\sin\theta}\frac{\partial}{\partial\lambda} \qquad (2) \\
\frac{\partial}{\partial z} &= \frac{\partial}{\partial r}
\end{aligned}
$$

and the relative acceleration of the particle southward may be written

$$\ddot{x}_1 = u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z} + \frac{\partial u}{\partial t} \equiv \frac{Du}{Dt} \ ,$$

which interpretation will always be attached to the operative symbol D/Dt; that is differentiation along a "stream-line," or along the path of a particle.

In a similar fashion, it may be shown that

$$\ddot{y}_1 = Dv/Dt \quad\text{and}\quad \ddot{z}_1 = Dw/Dt \quad ;$$

whence the components of the acceleration of the centroid of a particle are seen to be, respectively,

$$
\begin{aligned}
\ddot{x} &= \frac{Du}{Dt} - \frac{v^2}{r}\cot\theta + \frac{uw}{r} \\
\ddot{y} &= \frac{Dv}{Dt} + \frac{uv}{r}\cot\theta + \frac{vw}{r} \qquad (3) \\
\ddot{z} &= \frac{Dw}{Dt} - \frac{u^2}{r} - \frac{v^2}{r}
\end{aligned}
$$

If ϖ_1, ϖ_2, and ϖ_3 be the angular velocities of a particle of the fluid about axes directed southward, eastward, and zenithward, respectively, and, as before, positive when left-handed, the values of these components of the molecular rotation, in terms of the primary Cartesian system XYZ, will be[1]

$$\varpi_1 = \tfrac{1}{2}\left(\frac{\partial\dot{z}}{\partial y} - \frac{\partial\dot{y}}{\partial z}\right); \quad \varpi_2 = \tfrac{1}{2}\left(\frac{\partial\dot{x}}{\partial z} - \frac{\partial\dot{z}}{\partial x}\right); \quad \varpi_3 = \tfrac{1}{2}\left(\frac{\partial\dot{y}}{\partial x} - \frac{\partial\dot{x}}{\partial y}\right).$$

Substituting herein the values of $\dot{x}$, $\dot{y}$, $\dot{z}$, from equations (1), and making x, y, and z zero after performing the appropriate partial derivations, it will be found upon combination that

$$
\begin{aligned}
2\varpi_1 &= \frac{\partial w}{\partial y} - \frac{\partial v}{\partial z} - \frac{v}{r} \\
2\varpi_2 &= \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x} + \frac{u}{r} \\
2\varpi_3 &= \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} + \frac{v}{r}\cot\theta
\end{aligned}
$$

The relative motions of the particles of the fluid are completely determined by the three rates of elongation of lines of particles lying southward, eastward, and zenithward (corresponding to the "stretches" of the theory of elastic solids),

[1] Basset, Treatise on Hydrodynamics, Vol. I, p. 24.

and by the rates of distortion of the faces of a rectangular parallelopiped whose edges at the instant are oriented southward, eastward, and zenithward, respectively. These rates of distortion correspond to the "shears" of the theory of elasticity of solid bodies. The three rates of elongation may be denoted by s_x, s_y, and s_z, and the six rates of distortion, equal in pairs, by σ_{yz}, σ_{zx}, σ_{xy}, and σ_{zy}, σ_{xz}, σ_{yx}. In terms of the primary Cartesian system, these quantities are known to have the values:[1]

$$s_x = \frac{\partial \dot{x}}{\partial x}; \qquad \sigma_{yz} = \sigma_{zy} = \frac{\partial \dot{z}}{\partial y} + \frac{\partial \dot{y}}{\partial z};$$

$$s_y = \frac{\partial \dot{y}}{\partial y}; \qquad \sigma_{zx} = \sigma_{xz} = \frac{\partial \dot{x}}{\partial z} + \frac{\partial \dot{z}}{\partial x};$$

$$s_z = \frac{\partial \dot{z}}{\partial z}; \qquad \sigma_{xy} = \sigma_{yx} = \frac{\partial \dot{y}}{\partial x} + \frac{\partial \dot{x}}{\partial y};$$

or, substituting the expressions for $\dot{x}, \dot{y}, \dot{z}$ from (1), and evaluating at the point (θ, λ, r) as for the molecular rotations, there result the following rates of elongation:

$$s_x = \frac{\partial u}{\partial x} + \frac{w}{r}$$

$$s_y = \frac{\partial v}{\partial y} + \frac{w}{r} + \frac{u}{r} \cot \theta$$

$$s_z = \frac{\partial w}{\partial z}$$

and the following rates of distortion:

$$\sigma_{yz} = \sigma_{zy} = \frac{\partial w}{\partial y} + \frac{\partial v}{\partial z} - \frac{v}{r}$$

$$\sigma_{zx} = \sigma_{xz} = \frac{\partial u}{\partial z} + \frac{\partial w}{\partial x} - \frac{u}{r}$$

$$\sigma_{xy} = \sigma_{yx} = \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y} - \frac{v}{r} \cot \theta$$

At the same time the value of the "rate of dilatation" may also be found, or the rate at which a very small portion of the fluid is increasing its volume. This is a time rate, and is expressed by the following:

$$\varepsilon = \frac{\partial \dot{x}}{\partial x} + \frac{\partial \dot{y}}{\partial y} + \frac{\partial \dot{z}}{\partial z} = s_x + s_y + s_z$$

whence, upon substitution we have at the point (θ, λ, r),

$$\varepsilon = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} + \frac{2w}{r} + \frac{u}{r} \cot \theta$$

Kinetical considerations.—Let it be assumed that the stresses are linear functions of the rates of strain, and that the ratio of the tangential traction on any plane to the rate of shear on that plane is the coefficient of friction, μ, already noted. Let the normal tractions be

$$t_{xx}\,, \quad t_{yy}\,, \quad \text{and } t_{zz}$$

on the plane of the prime vertical, the meridian plane, and the horizontal plane of any point, respectively. Let the tangential tractions on the same planes be

$$t_{yz}\,, \quad t_{zy}; \quad t_{zx}\,, \quad t_{xz}; \quad \text{and } t_{xy}\,, \quad t_{yx}\,;$$

where the first suffix refers to the plane on which the stress is estimated, and the second suffix to the direction of its action. These tractions will be expressed, in terms of the rates of strain, by the following relations:[1]

$$t_{xx} = -p - \tfrac{2}{3}\mu\varepsilon + 2\mu s_x$$
$$t_{yy} = -p - \tfrac{2}{3}\mu\varepsilon + 2\mu s_y$$
$$t_{zz} = -p - \tfrac{2}{3}\mu\varepsilon + 2\mu s_z$$

$$t_{yz} = \mu\,\sigma_{yz} = t_{zy}$$
$$t_{zx} = \mu\,\sigma_{zx} = t_{xz}$$
$$t_{xy} = \mu\,\sigma_{xy} = t_{yx}$$

where p is the "fluid pressure" at any point, or the mean normal pressure over the surface of a particle, and is independent of the intermolecular friction, or of the relative motion of the particles.

The preceding formulas express the intensities of the tractions at the centroid of an elementary parallelopiped, with edges, dx, dy, and dz, respectively. Consequently, the net force in the southward, eastward, and zenithward directions at the centroid, due to the surface tractions, will be found by summing up the components in these directions of the total stresses on all six faces of the parallelopiped. The actual labor of accounting for all these tractions is tedious, owing to the curvatures of the spherical and conical faces of the elementary solid, causing certain of the tractions to have components in certain of the three principal directions at the centroid which would otherwise vanish. For inspection, however, these net forces are here given as follows: The total force on a particle of dimensions dx, dy, dz, due to the surface tractions, when resolved in the southward, eastward, and zenithward directions at the centroid, gives the following components, respectively:

$$\text{Southward} \ldots\ldots \left\{ \frac{1}{\sin\theta}\frac{\partial}{\partial x}(\sin\theta \cdot t_{xx}) + \frac{\partial}{\partial y}(t_{yx}) + \frac{1}{r^2}\frac{\partial}{\partial z}(r^2\, t_{zx}) \right\} dx\,dy\,dz - (t_{yy}\cot\theta + t_{zz})\,\frac{dx\,dy\,dz}{r}$$

$$\text{Eastward} \ldots\ldots \left\{ \frac{\partial}{\partial y}(t_{yy}) + \frac{1}{r^2}\frac{\partial}{\partial z}(r^2\, t_{zy}) + \frac{1}{\sin\theta}\frac{\partial}{\partial x}(\sin\theta \cdot t_{xy}) \right\} dx\,dy\,dz - t_{yz}\,\frac{dx\,dy\,dz}{r}$$

$$\text{Zenithward} \ldots\ldots \left\{ \frac{1}{r^2}\frac{\partial}{\partial z}(r^2 t_{zz}) + \frac{1}{\sin\theta}\frac{\partial}{\partial x}(\sin\theta \cdot t_{xz}) + \frac{\partial}{\partial y}(t_{yz}) \right\} dx\,dy\,dz - (t_{xx} + t_{yy})\,\frac{dx\,dy\,dz}{r}$$

It was before remarked that the equations of motion desired are to be found by equating the "expressed force" of a particle to the sum of the "impressed forces," and of the above given total force due to the surface tractions. If ρ is the density of the fluid, $\rho\,dx\,dy\,dz$ will be the mass of the particle, which multiplied by the acceleration (3) gives the "expressed force" in any direction. Hence, remembering the convention that the only impressed forces are those that like gravitation can be expressed in terms of a force-function that is dependent upon the radius only, and after reduction according to the previously deduced formulas and division by the mass of the particle, there result the following equations of motion:

[1] Lamb, Hydrodynamics, § 31 (where, however, $\sigma_{\lambda r} = 2f = \sigma_{r\lambda}$, etc.).

[1] Lamb, Hydrodynamics, § 284.

$$\frac{Du}{Dt} - \frac{v^2}{r}\cot\theta + \frac{uw}{r} = -\frac{1}{\rho}\frac{\partial p}{\partial x} + \frac{\mu}{\rho}\left[\frac{1}{3}\frac{\partial\varepsilon}{\partial x} + \Delta^2 u + \frac{2}{r}\frac{\partial w}{\partial x} - \frac{2\cot\theta}{r}\frac{\partial v}{\partial y} - \frac{u}{r^2\sin^2\partial}\right]$$

$$\frac{Dv}{Dt} + \frac{uv}{r}\cot\theta + \frac{vw}{r} = -\frac{1}{\rho}\frac{\partial p}{\partial y} + \frac{\mu}{\rho}\left[\frac{1}{3}\frac{\partial\varepsilon}{\partial y} + \Delta^2 v + \frac{2}{r}\frac{\partial w}{\partial y^1} + \frac{2\cot\theta}{r}\frac{\partial u}{\partial y} - \frac{v}{r^2\sin^2\theta}\right] \qquad (4)^1$$

$$\frac{Dw}{Dt} - \frac{u^2+v^2}{r} = \frac{\partial F}{\partial z} - \frac{1}{\rho}\frac{\partial p}{\partial z} + \frac{\mu}{\rho}\left[\frac{1}{3}\frac{\partial\varepsilon}{\partial z} + \Delta^2 w - \frac{2}{r}\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right) - 2w + \frac{2u\cot\theta}{r^2}\right]$$

where the Laplacian operator Δ^2, as applied to the modified polar coordinates, has the following interpretation:

$$\Delta^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} + \frac{\cot\theta}{r}\frac{\partial}{\partial x} + \frac{2}{r}\frac{\partial}{\partial z}\ .$$

To the above three general equations of motion must be joined the so-called equation of continuity,

$$\frac{D\rho}{Dt} + \rho\varepsilon = 0,$$

found, as usual, by equating the rate of increase of the mass in an elementary space due to the total rate of flow through the boundary to the rate of increase of the mass in that same space due to increase in density of the fluid.

It is also necessary to specify the relation between pressure and density at any point. Of the many hypotheses which might be formed as to this relation, the two simplest are: (*a*) that of homogeneity, and (*b*) that of uniform distribution of temperature. The hypothesis (*a*) means that the density ρ shall be considered constant, or that the rate of dilation shall be zero, thereby reducing the equation of continuity to

$$\varepsilon = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} + \frac{u}{r}\cot\theta + \frac{2w}{r} = 0$$

In the case of the earth the total height of the atmosphere if it were homogeneous would be

$$p_0/g\rho_0 = 5 \text{ miles, nearly,}$$

where p_0 and ρ_0 are the normal pressure and density at sea level; and the rate of decrement of the pressure with increase in altitude would be constant.

The hypothesis (*b*) is equivalent, analytically, to the isothermal law

$$\frac{p}{p_0} = \frac{\rho}{\rho_0}$$

These two hypotheses are manifestly at variance with the known properties of the atmosphere, whose density diminishes rapidly on ascent, and whose vertical temperature decrement averages 1° F. per 300 feet of altitude,[2] and they must be discarded, unless for special purposes, or unless only a rough degree of approximation is desired.

The hypothesis (*c*) that the equilibrium of the atmosphere is not static but convective, and is kept up by ascending and descending columns of air which fall and rise in temperature through their expansion and compression without sensible change of the total quantity of heat, gives better promise. This is equivalent to the so-called adiabatic law, or the law governing the expansion of a gas without transmission of heat,

$$\frac{p}{p_0} = \left(\frac{\rho}{\rho_0}\right)^\gamma$$

where $\gamma = 1.406$ = ratio of specific heat of air at constant pressure to specific heat at constant volume.[3]

[1] If these equations are preferred in terms of derivatives with respect to terrestrial polar coordinates ($\theta, \lambda, r,$) instead of local coordinates (x, y, z), the change may be readily effected by the aid of equations (2).
[2] Davis, Elementary Meteorology, § 36.
[3] Wood, Thermodynamics, p. 54.

The total height of an atmosphere following the adiabatic law would be about 17 miles; the pressure would be reduced to one half its sea-level value at an altitude of slightly over 3 miles; to 1/10 at 8.4 miles, to 1/100 at about 13 miles, and to 1/5000 at an altitude of about 16 miles, if gravity be considered constant, the atmosphere in a stable condition, and the effect of the earth's rotation neglected.

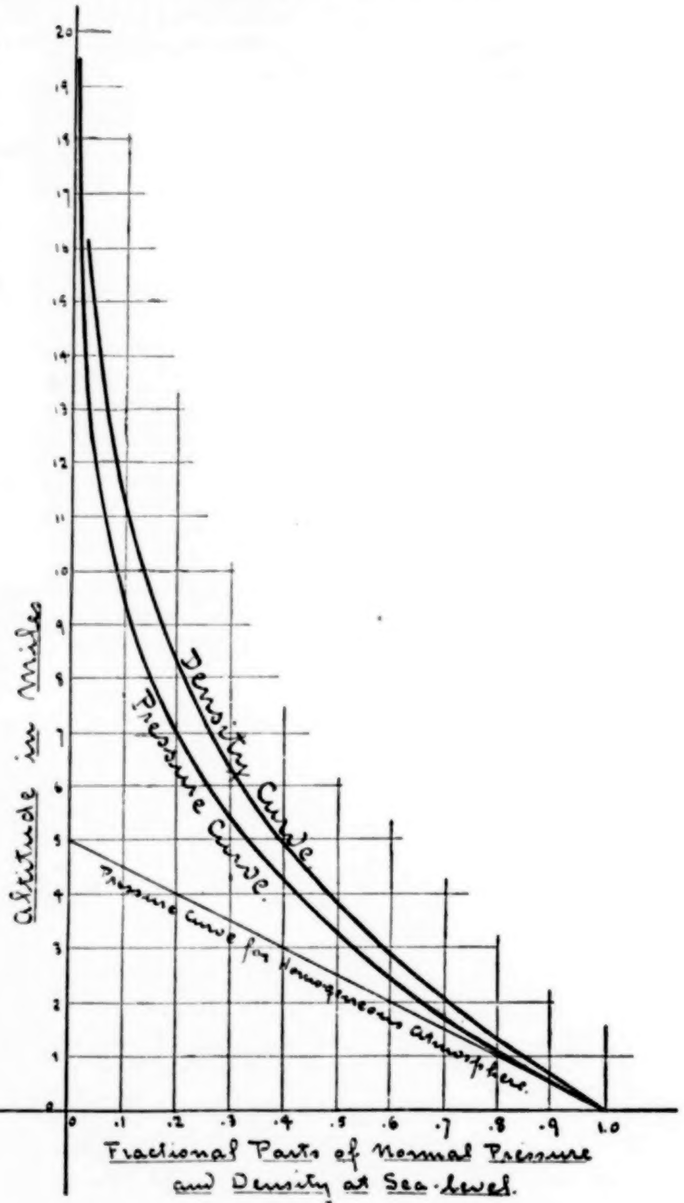


FIG. 3.—Pressure graph of atmosphere, on hypothesis of uniform decrease of temperature at rate of 1° F. per 100 yards ascent. $\nu = 1.2$.

Even this hypothesis does not represent the observed state of the atmosphere accurately, since it means a rate of decrease of 1.6° F. per 100 yards increase in altitude, instead of

the 1° F. which the presence of moisture in the air and other causes conspire to determine.

As the observed rate of decrease of temperature lies between hypotheses b and c, let it be assumed (d) that

$$\frac{p}{p_0} = \left(\frac{\rho}{\rho_0}\right)^\nu. \tag{5}$$

It is easy to so determine ν that the temperature shall decrease at the observed average rate of 1° F. per 100 yards. Thus considering g as constant, and the atmosphere in a state of stable equilibrium,

$$p = \int_z -\rho\, g\, dz, \text{ whence } dp = -\rho\, g\, dz, \tag{6}$$

where z is the altitude above the surface of the earth. Eliminating ρ from (5) and (6) and integrating, there results

$$p_0^{\frac{\nu-1}{\nu}} - p^{\frac{\nu-1}{\nu}} = \frac{\nu-1}{\nu}\,\frac{g\,\rho_0}{p_0^{1/\nu}}\, z,$$

where $p = p_0$ when $z = 0$. But if τ is the absolute temperature of the atmosphere (temperature in Fahrenheit degrees + 461°, or in Centigrade degrees + 274°) and if the air is a perfect gas it must satisfy the well-known relation

$$\frac{p}{\rho\,\tau} = \frac{p_0}{\rho_0\,\tau_0} = 1{,}713$$

in British units, where p = poundals/ft.^{2} and ρ = lbs./ft.^{3}; or

$$\frac{p_0}{\rho_0\,\tau_0} = 2{,}864{,}000$$

in C. G. S. units, when p = dynes/cm.^{2} and ρ = gr./cm.^{3}; τ being measured in Fahrenheit degrees in the former case, in Centigrade degrees in the latter.

Making use of equations (5), (6), and (7), ν may be determined so as to make

$$\frac{d\tau}{dz} = -\frac{1}{300}\ \text{F.°/ft.},$$

so as to accord with the observed value of the rate of diminution of temperature. The value thus found is approximately $\nu = 1.2$.

The total height of an atmosphere satisfying this law,

$$\frac{p}{p_0} = \left(\frac{\rho}{\rho_0}\right)^{1.2},$$

would be about 30 miles; the pressure would be reduced to one-half its value at sea level at an altitude of $3\frac{1}{4}$ miles, to 1/10 at $9\frac{1}{2}$ miles, to 1/100 at 16 miles, and to 1/5000 part at an altitude of about 23 miles. These values are somewhat affected by the diminution of the value of g with increasing altitude and by the presence and increase of the centrifugal force due to the rotation of the earth.

The agreement with the known properties of the atmosphere is much closer than under the preceding hypotheses; it is sensibly exact at lower altitudes, and although the atmosphere is believed to extend in a state of extreme tenuity to a height considerably greater than 100 miles, no significant pressure would be encountered at an altitude of 45 or 50 miles. It is estimated that at an altitude of 30 miles the pressure is but $\frac{1}{200}$ of an inch of mercury[1] (about 1/6000 of the pressure at sea level), a discrepancy of less than 20 per cent in altitude between the calculated and estimated values at this low pressure.

A graph of the pressure and density distributions under this law is given in Fig. 3.

If the law of distribution of the absolute temperature be assumed (e) to be any other function of the radius or altitude, and if need be also of the latitude, the relation between pressure and density may be found by eliminating the temperature between this assumed law and equation (7).

In the equations as thus far discussed, no specific reference has been made to the rate of rotation of the earth, which may be regarded as possessed of a constant angular velocity

$$\omega = \frac{2\pi}{86{,}164} = 0.0000729 \text{ Sec.}^{-1}$$

about its polar diameter. An exactly sufficient allowance for this rotation will be made by substituting for (v) the value ($v + \omega r \sin\theta$) wherever v appears in the left-hand members of the three equations of motion, except in the interpretation of the operator D/Dt, which refers to an operation relative to the earth.

Thus, the corrected equations of motion (4) become

$$\begin{aligned}
\frac{Du}{Dt} - \frac{v^2}{r}\cot\theta + \frac{uw}{r} - 2v\,\omega\cos\theta - \omega^2 r\sin\theta\cos\theta &= -\frac{1}{\rho}\frac{\partial p}{\partial x} + \frac{\mu}{\rho}\Big[\cdots\cdots\Big] \\
\frac{Dv}{Dt} + \frac{uv}{r}\cot\theta + \frac{vw}{r} + 2u\,\omega\cos\theta + 2w\,\omega\sin\theta &= -\frac{1}{\rho}\frac{\partial p}{\partial y} + \frac{\mu}{\rho}\Big[\cdots\cdots\Big] \\
\frac{Dw}{Dt} - \frac{u^2+v^2}{r} - 2v\,\omega\sin\theta - \omega^2 r\sin^2\theta &= \frac{\partial F}{\partial z} - \frac{1}{\rho}\frac{\partial p}{\partial z} + \frac{\mu}{\rho}\Big[\cdots\cdots\Big]
\end{aligned} \tag{8}$$

Now if the atmosphere is in a state of relative rest, so that $u = v = w = 0$, these equations reduce to

$$\frac{1}{\rho}\frac{\partial p}{\partial x} = \omega^2 r\sin\theta\cos\theta$$

$$\frac{1}{\rho}\frac{\partial p}{\partial y} = 0$$

$$\frac{1}{\rho}\frac{\partial p}{\partial z} = \frac{\partial F}{\partial z} + \omega^2 r\sin^2\theta$$

the resultant of which forces must be normal to the earth's spheroid, or to the level surface of the earth. But, according to the assumption whereby the eccentricity of the earth was neglected and the earth considered spherical, that level surface must be spherical, and

$$\frac{1}{\rho}\frac{\partial p}{\partial x} = 0$$

$$\frac{1}{\rho}\frac{\partial p}{\partial y} = 0$$

$$\frac{1}{\rho}\frac{\partial p}{\partial z} = -g$$

Hence, to give consistent results with the arbitrarily chosen spherical equipotential surface, the quantity ($\omega^2 r\sin\theta\cos\theta$)

[1] Davis, op. cit., p. 13.

of the first equation must be discarded, and for $\left(\frac{\partial F}{\partial z}+\omega^2\sin^2\theta\right)$ of the third equation must be substituted $(-g)$.[1]

Still g will vary with the altitude; and if g_0 is its value at the radius a, then

$$g = g_0 a^2/r^2$$

for points exterior to the earth.

Now the mean mass-altitude of the atmosphere, or the altitude of the centroid of a vertical column of air, according to the suggested relation between pressure and density, is about $4\frac{1}{4}$ miles. Therefore, if the mean atmospheric radius be considered as $a = 3,959 + 4 = 3,963$ miles, or 6,377 kilometers, an error of 1 per cent in terms containing $1/r^2$, and of only one-half of 1 per cent in terms containing $1/r$, will be made by considering r constant and equal to a at as great a distance from the surface of the earth as 24 miles, at which altitude the density of the air is inappreciable and its effect on the general circulation a minimum; whereas at the surface of the earth, where the density is a maximum, the error induced by considering r constant will not sensibly exceed one-fifth of 1 per cent in terms containing $1/r^2$, nor one-tenth of 1 per cent for terms in $1/r$. The quantity g is the term most affected by this change; yet the error is small and constant for any stratum concentric with the earth. It will therefore not give rise to any disturbing pressure gradient, and it may be concluded that all necessary accuracy will be obtained, if we consider $r = a = 3,963$ miles, wherever that quantity enters explicitly in the equations of motion.[1]

Certain terms of these equations are always negligibly small. Thus the actual component of the wind velocity parallel to the surface of the earth can not well reach as high a value as 200 miles per hour; yet if that were possible the quantity $(v^2 + u^2)/a$ of the third of equations (8) would not exceed 0.000008 ft./sec.^{2}, and the maximum value of the quantity $2\,\omega\, v \sin\theta$ in the same equation would be less than 0.002 ft./sec.^{2}, both of which may be neglected in comparison with the value of g. In that same equation, the quantity $2\frac{\mu}{\rho}\frac{w}{a^2}$ may be similarly neglected. Several other terms may be negligibly small if the territory covered by the particles under analysis does not include the terrestrial poles; but the resulting changes are obvious.

Making only those alterations specifically noted, the general equations of motion are obtained in their final forms as follows:

$$\frac{Du}{Dt} - \frac{v^2}{a}\cot\theta + \frac{uw}{a} - 2\,v\,\omega\cos\theta + \frac{1}{\rho}\frac{\partial p}{\partial x} = \frac{\mu}{\rho}\left[\frac{1}{3}\frac{\partial\varepsilon}{\partial x} + \Delta^2 u + \frac{2}{a}\frac{\partial w}{\partial x} - \frac{2\cot\theta}{a}\frac{\partial v}{\partial y} - \frac{u}{a^2\sin^2\theta}\right]$$

$$\frac{Dv}{Dt} + \frac{uv}{a}\cot\theta + \frac{vw}{a} + 2\,u\,\omega\cos\theta + 2\,w\,\omega\sin\theta + \frac{1}{\rho}\frac{\partial p}{\partial y} = \frac{\mu}{\rho}\left[\frac{1}{3}\frac{\partial\varepsilon}{\partial y} + \Delta^2 v + \frac{2}{a}\frac{\partial w}{\partial y} + \frac{2\cot\theta}{a}\frac{\partial u}{\partial y} - \frac{v}{a^2\sin^2\theta}\right]$$

$$\frac{Dw}{Dt} + g + \frac{1}{\rho}\frac{\partial p}{\partial z} = \frac{\mu}{\rho}\left[\frac{1}{3}\frac{\partial\varepsilon}{\partial z} + \Delta^2 w - \frac{2}{a}\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right) - \frac{2\,u\cot\theta}{a^2}\right],$$

where the operator D/Dt and the Laplacian operator Δ^2, and the dilatation ε, have already been defined. To these equations are to be added the equation of continuity of the fluid, and the relation between pressure and density. In the case of frictionless or "perfect" fluids, the second members will be each made zero.

NOTE.—In the United States Coast Survey Report for 1875, p. 372, Ferrel gives in his equations (8) formulas differing from equations (8) of this present paper by the factor 2. Thus, Ferrel's equations would give the following instead of our equation (8):

$$\frac{Du}{Dt} - \frac{v^2\cot\theta}{r} + \frac{{}^*2\,uw}{r} - 2\,\omega\,v\cos\theta - \omega^2 r\sin\theta\cos\theta = -\frac{1}{\rho}\frac{\partial p}{\partial x} + \ldots.$$

$$\frac{Dv}{Dt} + \frac{{}^*2\,vw}{r} + \frac{{}^*2\,uv\cot\theta}{r} + 2\,\omega\,w\sin\theta + 2\,\omega\,u\cos\theta = -\frac{1}{\rho}\frac{\partial p}{\partial y} + \ldots.$$

$$\frac{Dw}{Dt} - \frac{u^2 + v^2}{r} - \omega^2 r\sin^2\theta - 2\,\omega\,v\sin\theta = \frac{\partial F}{\partial z} - \frac{1}{\rho}\frac{\partial p}{\partial z} + \ldots.$$

The superfluous factors 2* are errors in Ferrel's equations, introduced in the passage from equations (7) of his paper to (8).

In fact, the accelerational terms of his equation (7) are

$$D_t^2\theta\ ,\quad D_t^2\lambda\ ,\quad \text{and}\quad D_t^2 r\ ,$$

or which is equivalent,

$$D_t(u/r)\ ,\quad D_t(v/r\sin\theta)\ ,\quad \text{and}\ D_t w\,.$$

This symbol D is, in the paper referred to, treated as the symbol of partial derivation with respect to the time, a similar notation being used for partial derivatives with respect to the space coordinates. In this lies Ferrel's error, for D_t is identical with the operator D/Dt of this paper, and is a total derivative, defined in terms of the quantities appearing in the equations by

$$u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y} + w\frac{\partial}{\partial z} + \frac{\partial}{\partial t}$$

By introducing this correct interpretation of the operator D_t the equations deduced from (7) of Ferrel's paper will be exactly equivalent to our equations (8).

This error has already been pointed out by Sprung,[2] who derived the equations in a different manner.[3]

[1] Compare Ferrel, "Recent Advances in Meteorology," Report of the Chief Signal Officer, U. S. War Department, 1885, Part II, p. 184.

[1] At that altitude $g_0 = 32.08$ ft./sec.^{2} Cf. Thomson and Tait, "Treatise on Natural Philosophy," Vol. I, Part 2, § 801.

[2] Meteorologie, 1885, p. 208.

[3] It had also been recognized by Ferrel (see his Meteorological Researches No. III, 1882, p. 46, or Report of Coast and Geodetic Survey for 1881, p. 268) and does not reappear in his Recent Advances, Washington, 1885, but has unfortunately been copied, inadvertently, by several subsequent authors.—ED.

NOTES BY THE EDITOR.

DEATH OF MR. JOSEPH COTTIER.

Among the special contributions to the current number of the MONTHLY WEATHER REVIEW is one that we esteem of much importance to those who are studying the fundamental problem of meteorology. This paper was sent us by Mr. Cottier on June 29, and we anticipated great pleasure in introducing Mr. Cottier and his subject to the readers of the MONTHLY WEATHER REVIEW. But, alas! our pleasure is turned to grief by the intelligence of Mr. Cottier's untimely death, from typhoid fever, on August 17, at Paris. Mr. Cottier was a young man of brilliant promise. He was about to enter upon the last year of a well-deserved fellowship in science in Columbia University, New York City. The memoir with which he honored the MONTHLY WEATHER REVIEW was his last work before starting on his vacation trip. It may be considered as a special application of a more general work on hydrodynamics that he had nearly finished, under the stimulus of Prof. R. S. Woodward, of Columbia. Doubtless this latter memoir will also be published, and both will serve to fix in the annals of science the name of one whose early death is a sad loss to meteorology.

DEATHS OF WEATHER BUREAU OBSERVERS.

Mr. B. S. Pague, local forecast official and section director for Oregon, sends us the following notes in connection with his report for July:

Mr. W. H. Goudy, voluntary observer, died at Hubbard, Oreg., on July 12, aged seventy-five years. He was a pioneer in Oregon, a successful farmer, and a highly respected citizen.

Prof. S. E. McClure, in charge of the meteorological work at the State University, Eugene, Oreg., was killed the night of July 27, 1897, while descending Mount Ranier, Wash. He accompanied the Mazama party and conducted the observations. In descending, his foot slipped and he was precipitated down a 300-foot incline and was instantly killed. He was thirty-five years old, highly intelligent, of good promise, popular, and respected. He was killed while pursuing scientific work. The Bureau has lost two valuable men.

RETIREMENT OF PROFESSOR HANN.

From the London Geographical Journal for September, 1897, we learn that Prof. Julius Hann has, at his own request, been relieved of the post of Director of the Central-Anstalt fur Meteorologie und Erdmagnetismus, which he held in conjunction with that of Professor of Terrestrial Physics at the University of Vienna, and has been appointed Professor of Meteorology at Gratz, in Styria. While recognizing the eminent merit of Professor Pernter, yet we are sure that the meteorologists of America will unite with those of Europe in regret that Professor Hann has been forced by sickness to seek a relief from his onerous duties in Vienna. One can but hope that he may be able to accomplish at Gratz even more than he has done at Vienna for meteorology.

CLOUD HEIGHTS AT TORONTO.

In the Monthly Weather Review of the Canadian Meteorological Service for the month of May the director, Prof. R. F. Stupart, publishes the first that we have seen of the results of the observations of the heights and velocities of clouds made at Toronto in accordance with the recommendations of the International Meteorological Committee. The published observations represent only seven days out of the thirty-one, but they are worth reproducing in order that our correspondents may obtain the earliest possible information with regard to the results of this important work. It is understood that the work done by the Weather Bureau and, possibly, also that of the Blue Hill Observatory will be published as a whole in one report.

In the following table we have rearranged the Toronto observations according to the heights of the clouds instead of the day of the month. The reader will, therefore, more easily perceive the range of altitudes through which clouds of any given class are observed, as also the slow rate of increase of velocity with altitude on any given day as contrasted with the rate for any given class of clouds. The table emphasizes the futility of any effort to ascribe an average height or velocity to any given class of clouds. For instance, there can be no doubt but what the cumulus clouds exist throughout such a wide range of altitude at Toronto (and throughout a much wider range if we consider both the tropical, the temperate, and the polar regions) that any system of nomenclature that ascribes to them specific altitudes must lead to great confusion. The present table shows us that cirro-cumulus exists at altitudes of 6,000 and 10,000 meters, while the cirrus proper come in between, at 7,000 or 8,000.

Cloud heights, Toronto, May, 1897.

Name of cloud.	Altitude.	Moving from—	Velocity, hourly.	Date.	Time.
	Meters.	°	*Miles*		*h. m.*
Cirro-cumulus	10,032	n. 17 w.	91.8	7	2 06 p. m.
Cirro-cumulus	7,626	s. 45 w.	42.9	15	10 57 a. m.
Cirrus	7,335	n. 42 w.	38.6	21	12 53 p. m.
Cirrus	7,089	n. 42 w.	38.7	21	12 43 p. m.
Cirro-cumulus	6,135	n. 6 w.	65.8	17	12 33 p. m.
Strato-cumulus	3,949	s. 65 w.	53.5	12	2 30 p. m.
Strato-cumulus	2,806	s. 35 w.	48.4	14	2 46 p. m.
Strato-cumulus	2,624	s. 41 w.	48.0	14	2 35 p. m.
Cumulus or alto-cumulus	2,302	s. 56 w.	32.6	13	3 01 p. m.
Cumulus	2,301	n. 41 w.	20.9	15	10 27 a. m.
Cumulus or alto-cumulus	2,283	s. 46 w.	33.6	13	2 45 p. m.
Cumulus or alto-cumulus	2,174	s. 47 w.	24.3	13	2 35 p. m.
Cumulus or alto-cumulus	2,030	s. 61 w.	32.8	13	2 50 p. m.
Cumulus	1,971	s. 44 w,	43.7	14	2 51 p. m.
Cumulus	1,936	s. 47 w.	36.8	14	2 22 p. m.
Stratus	1,042	n. 40 w.	21.7	21	12 58 p. m.

NOTE.—A few of the figures in the above table are open to some uncertainty, owing to defective type in the printed page from which the data are taken.

RAIN GUSHES IN THUNDERSTORMS.

Mr. Edgar Richardson, at Healdsburg, Colo., under date of July 27, says:

When living in West Virginia I used to observe that, during a thundershower, after every clap of thunder the rain would come down with increased quantity for a few moments and then let up again. The whole effect seemed to be caused by the thunder discharge letting loose an increased quantity of water above. I once saw an explanation of this, but have lost it. Will you kindly explain the cause, if possible?

Several plausible methods of explaining this phenomenon have been accepted from time to time in the history of meteorology, but the progress of our knowledge has successively dissipated these explanations as erroneous, but without, as yet, replacing them by something nearer the truth.

One of the oldest suggested explanations was that the commotion in the air produced by the thunder jostled the cloud particles together into larger drops that fell as rain. Generally the drops reach the ground so soon after the thunder, possibly even at the same time with it, that this explanation fails. Even the large drops would require ten seconds to fall 1,000 feet, and the clouds are much higher than that; moreover, no amount of noise, such as the firing of a gun into a small cloud of escaping steam, will produce any such formation of large drops. The idea that violent explosions can produce rain was thoroughly refuted by the famous experiments made by Dyrenforth a few years ago in Texas. Equally erroneous is the idea that has been widely believed in for several hundred years that explosions and cannonadings can break up and dissipate hailstorms, thunderstorms, and rain, when they are not wanted.

The rain from every cloud always comes down more or less intermittently, it may be in short, heavy showers, or in longer, gentle alternations. We do not know enough of the natural process by which rain is formed within a cloud to understand why this intermittent action should so generally occur, but any one watching the progress of a rain cloud from some height where he may command a broad landscape will observe it dropping its rain here and there as it moves along. Even if there were no connection, by way of cause and effect, between the noise of the thunder and the fall of the rain, yet there would always be some observers in the path of the rain cloud who would be able to say that the rain fell upon them just after they heard the thunder. There will, of course, be many more who will have observed that the rain came with or even before the thunder, and it will hardly do for us to attempt to explain the reasons why heavy rain follows the thunder until we have first satisfied ourselves that it does not equally often precede the thunder. It would take a very careful observer to accumulate the necessary statistics. He should give us the following numerical data, viz: How many times in the course of a year has heavy rain followed after the thunder within 1, 2, or .... 10 seconds and how many times has the rain preceded the thunder by 1, 2, or .... 10 seconds?

There can be no doubt but what thunder, which is formed simultaneously with the lightning, reaches the observer's ears some time after he sees the flash, and the Editor has always thought it likely that the special showers of rain have a direct connection with the flash rather than with the thunder. So far as his own observations go, the shower has always followed the flash and not the thunder; in fact, the thunder and shower often reach us at the same time. Some very accurate observations on thunder and lightning were recorded by Mr. Stillman Masterman, of Weld, Franklin County, Me., both at that place and at Stillwater, Minn. These are published in the Annual Report of the Smithsonian for 1855, pages 265–282. His records give the details of each individual flash of lightning and resulting thunder. In the storm of the afternoon of July 9, 1854, the details of over fifty flashes are given, and one case is noted in which a flash, whose thunder became audible within two seconds and was entirely over within five seconds, was preceded by the gush of rain. Similarly, in the storm of September 6, 1854, one flash was preceded by five seconds and another flash was preceded by one second, by the gush of rain. On June 14 and 15, 1852, Mr. Masterman says:

> I noticed that for several succeeding discharges of the electric fluid, there was in every instance a sudden and violent gush of rain, immediately *previous* to the flash of lightning. I have observed a like phenomenon on several previous occasions.

It is at present an open question whether the gushes of rain in any way bring about the formation of lightning, or whether the formation of lightning produces or accompanies the formation of the raindrops. In fact, both may be true, each under appropriate circumstances, but there is no reason to associate the thunder and the gushes of rain together as a case of cause and effect.

(1) When gushes of rain closely attend the lightning it is not improper to consider the falling rain as a mass of electrified drops conveying the electricity from the cloud region to the earth's surface; when they have approached the latter within "the striking distance," then the flash of lightning springs forth. The occurrence of the lightning is, therefore, in such cases due to the presence of a column of descending raindrops.

(2) When the rain precedes lightning by several seconds, as in the case observed by Mr. Masterman, this explanation, of course, does not apply.

(3) When the rain follows the lightning at an interval of several seconds the connection betwen them may be either accidental or casual.

(3*a*) In the first case, the rain started from the cloud independently of the lightning and reached the observer a few seconds later, partly because it took that time to reach the ground, and partly because it took time to be carried along horizontally by the wind as it fell to the earth. Both the vertical motion and the horizontal motion are involved in the time that elapses between leaving the cloud and reaching the observer.

(3*b*) If the connection is causal then, probably the lightning and the raindrops are formed at the same instant, and the time that elapses between the observer's observation of the flash and the shower is essentially the time occupied by the drops in falling to the earth's surface.

As the Editor has elsewhere said, a cloud is essentially a collection of particles of water condensed upon dust and other foreign matter as nuclei. These particles are surrounded by an atmosphere that is saturated with vapor but not yet condensed. As this saturated air cools it becomes supersaturated, and when this condition has proceeded to a point comparable with that which obtains in a state of unstable equilibrium, the vapor molecules from a comparatively large sphere of supersaturated space are, by their molecular attractions, suddenly brought together into heavy drops of warm water and descend rapidly from the clouds while the latent heat of condensation is communicated to the adjoining air and left behind in the cloud. At the same moment electricity, possibly due to the molecular disruption involved in the passage of vapor from the condition of extreme supersaturation to the sudden formation of large drops of water, or possibly of snow or ice, gives rise to the lightning flash.

All these suggestions looking toward an explanation of the connection between thunder, lightning, and gushes of rain must be understood to be merely so-called working hypotheses, which need to be tested by further experiment and corrected, and possibly entirely abandoned.

IMPORTANCE OF SOUND THEORIES.

It is very common to hear it said that "facts are more important than theories," by which we are to understand that untried theories or fanciful hypotheses are intended; the theories of a person who is not in touch with actual experience. Meteorologists, in their attempts to get at the laws of nature, have always suffered, from the fact that they can not experiment with the atmosphere on a large scale; we can even rarely collect enough observations to enable us to understand what is going on above and below over any large storm area. The history of our science has been, like the history of every other branch of science, marked by the formulation and destruction of a long series of hypotheses as we have proceeded step by step toward a better knowledge of the secrets of the atmosphere. The past forty years has been especially rich in a kaleidoscopic series of developments in the views of those who are leading our thoughts toward the rational and true mechanics of the atmosphere. It is no disparagement to an honest seeker to be told that he has learned something, and has been forced to change an opinion within the past ten years, but it is, on the contrary, rather to his disparagement to confess that he has seen no reason to make any change in his former belief, notwithstanding the results of the researches of the many energetic physicists who have devoted their time and thoughts to meteorology.

We have been led to these thoughts by reading the latest pamphlet published by Faye of Paris, entitled "New Studies on Hurricanes, Cyclones, Waterspouts or Tornadoes," and have been forced to coincide with the sentiment of the following quotation from an admirable article in our cotemporary, Nature, of July 29:

> As a general rule it is a matter of perfect indifference to the ordinary purposes of life whether we hold a correct or an incorrect theory

in astronomy or meteorology. Life and commerce and navigation would go on the same whether we believed that the earth went round the sun, or the sun round the earth. But in this matter of tempests and cyclones, trade and commerce can be very adversely affected if we teach an incorrect theory of their origin and motion. A captain can only hope to escape from the danger with which they threaten him by localizing, with some precision, the situation of the inner vortex. To do this he has but one guide, the direction of the wind. The use he makes of this guide in inferring the position of the ship with reference to that of the storm center will be materially affected by the views he holds concerning the motion of the wind in a cyclonic storm. A rule must be devised for his guidance without ambiguity, and one that can be followed without hesitation. Piddington and the older meteorologists held that the movement of the wind in a cyclone was circular. In this view they are followed by Mr. Faye. The result of this belief was the enunciation of the rule of eight points expressed something in this way: With the face turned to the wind extend the right arm. In the Northern Hemisphere you will point in the direction of the storm center. This rule can be supported only by ignoring a great mass of recent observations. The rule asserts that the wind blows at right angles to the radius, but it has been shown over and over again that in true cyclones the winds are strongly inclined inwards, not directly to the center, but approaching it by a spiral. A more accurate rule has been deduced and is supported by weighty authorities, but not by Mr. Faye. In the Northern Hemisphere, with face to the wind, the direction of the center is from ten to eleven points to the right-hand side. To go back to the old rule of Piddington is a retrograde step, but the mischief does not end there. The distrust likely to be awakened in the mind of the seaman by the spectacle of disaccord among the scientific authorities can have the most disastrous results. The ordinary seaman asks for a clear and precise rule on which he can act without argument or question, while his whole attention is directed to the preservation of his ship. M. Faye is great authority. His name is one to conjure with, and it is not unlikely that the rules which he quotes with approval will be copied into English books by those who compile manuals of brief and ready directions for navigation, and in this way perpetuate an evil against which a mass of scientific evidence, collected in less accessible quarters, is powerless.

THE OBSERVATION OF HALOS.

The communication on a preceding page from the Rev. K. Schipps illustrates the remarks made in a recent number of the MONTHLY WEATHER REVIEW to the effect that meteorology offers innumerable fields of interest to the special observers, and there doubtless are a few in this country who, as students of physical or optical meteorology, will be glad to take up the subject of halos with the enthusiasm of the Halo Committee, represented by our learned correspondent. Students of meteorology will profit by a study of the treatment of this subject in the first and third volumes of the Traité d'Optique (Paris, 1893), by Mascart, the Director of the Meteorological Central Bureau of France. The ordinary rainbow is a well-known illustration of a solar halo, whose angular distance from the sun is from 138° to 140°, that is to say, about 40° or 42° from the anti-solar point or from the direction of the shadow of the observer. The general theory of the rainbow and its supernumerary arcs, as deduced from the wave theory of light, is given by Mascart (Chapter V), but a most elaborate investigation of the subject, together with a series of exact observations of rainbows, has just been published by Prof. J. Pernter, the newly-appointed successor to Prof. Dr. Hann as Director of the Central Institute for Meteorology and Terrestrial Magnetism at Vienna.

With regard to the names of the halo phenomena referred to by Dr. Schipps as proper to be used in the observers' condensed descriptions, the following list, compiled from Mascart's Treatise, will be helpful:

Corona, or glory. A circle of light or color surrounding the sun or moon or any other luminary, either celestial or terrestrial; the angular radius of such circles very rarely exceeds 5°; the largest that has yet been observed is the so-called Bishop's circle of about 15° radius, first described by Sereno Bishop of Honolulu, in connection with the haze due to the eruption of Krakatoa, August 27, 1883.

Anti-solar coronas or anti-lunar coronas. Similar small circles of light or bands of color surrounding the anti-solar point, and seen with especial beauty when, from a mountain top or a balloon, the observer's shadow is cast upon the clouds, and sometimes when it is simply cast upon a meadow covered with dewdrops.

Shadow beams, or perspective beams, or solar beams, or beams of light and shade. These beams, due to the shadows of clouds in the sky, or of mountains and terrestrial objects when the sun is below the horizon, appear to converge toward the solar and the anti-solar points, and are widest apart in the region perpendicular to the line joining the sun with the observer. They are, in fact, parallel with each other, and the convergence is only an illusion of perspective.

Primary rainbow. A halo of 40° or 42° radius from the anti-solar point, a brilliant circle of spectrum colors.

Secondary bow, or secondary rainbow. A halo of feebler light than the primary rainbow, and having a larger radius, viz, from 50° to 54° from the anti-solar point. The secondary rainbow is sometimes called the reflected bow as though it were the reflection of the primary, but this is not proper.

Tertiary rainbow. A halo having a radius of 41° from the sun; quarternary rainbow, a halo of 44° from the sun; quinary rainbow, a halo of 54° from the anti-solar point. The 3d, 4th, and 5th orders of rainbow are too feeble to be ordinarily observed.

Supernumerary arcs. The colored fringes that border almost every system of rainbow colors, and especially on the inside of the secondary rainbow.

Reflected halos or reflected bows. These are sometimes seen by reflection, properly so called, from the smooth surface of rivers or lakes.

The white rainbow. A halo of between 33° and 42° radius from the anti-sun, described first by Mariott, but more frequently known as Ulloa's circle.

The peculiarities of all halos depend upon the size of the particles or drops of water, the uniformity in size and shape, the number of reflections within the drops, and the mutual distance of the drops or particles from each other. Ulloa's white rainbow appears to be formed, according to Mascart, by the overlapping of bows formed by a mixture of drops of all sizes.

The second set of optical phenomena are due to the presence of crystals of ice, hexagonal prisms, flat plates, and hexagonal pyramids, either alone or in combination with drops of water. The optical phenomena due to these may be designated by the following among other names:

Anti-sun or anthelion. The bright spot or point directly opposite the sun, or directly in the line of the shadow of the observer's head.

Halo of 22° radius from the sun.

Halo of 46° radius from the sun.

The tail of the halo; a projection attached to the halo of 22°, and also to the halo of 46°.

Parhelic circle. A horizontal white band passing through the sun and sometimes entirely around the heavens parallel to the horizon.

Parhelion of 22°. A bright spot on the parhelic circle 22° to the right and left of the sun.

Tail of the parhelion. A short extension of the bright light from the parhelion, or mock, or false sun, extending vertically or horizontally.

Parhelion of 46°. The bright spot 46° from the sun at the intersection of the halo of 46° with the parhelic circle. This parhelion also has a tail streaming along both its intersecting circles, especially the halo circle.

Paranthelia. The mock suns that appear when the true sun is very near the horizon and which can appear in the parhelic circle on either side of the anthelion and at about

46° and 82° distant from it. There is a third paranthelion at 38° and a fourth one at 60°, the latter being white.

Tangent arcs. These may be tangent at the top and bottom of the halo circle of 22°. When perfect they have two branches, one pair running off indefinitely and the other circumscribing the halo of 22°.

Circumzenithal parhelic circle. A horizontal circle tangent or quasi-tangent to the halo of 46°.

Lateral tangential arcs. These are arcs tangent to the lower part of the halo of 46° at points considerably to the right or left of the vertical circle from the zenith through the sun. Corresponding supra-lateral tangent arcs may also occur tangent to the same circle on the right and left hand sides of its summit; in fact, in one position only, the upper and lower lateral arcs may become continuous and inclose the halo of 46°.

Lateral arcs tangent to the halo of 22°. They are known as the arcs of Lowitz; they are of short extent and only clearly disengaged from the halo when the sun is quite high above the horizon.

Columns of light. Bright white columns passing vertically through the sun.

Solar cross. The intersection of a bright vertical column and a bright horizontal bar with the sun or the anti-sun at the center.

Oblique parhelic circle. This is analogous to the horizontal parhelic circle, except for its inclination.

Oblique arcs through the anthelion or through the sun. These are usually inclined about 30° to the vertical, or 60° to each other.

St. Andrew's cross. Two oblique arcs passing through the sun incline to each other at 60°.

As all these phenomena are due to the reflection and refraction of sunlight by crystals of ice floating in the air, the frequency of the phenomena will depend, other things being equal, upon the relative frequency with which crystals of the proper form and position occur in the sky. European observations gave Bravais the following results. (See Mascart, Optique, Vol. III, p. 518.) Let all the halo phenomena be divided into four classes, as follows:

I.—When the axes and facets of the ice crystals are distributed by chance, which is the great majority of cases, we perceive then only the two principal halos of 22° and 46°, and sometimes the halos due to prisms whose angles differ from the 60° or 90° that occur in the normal prisms of ice.

II.—When the prisms have a vertical axis they produce the parhelia of 22°, the quasi-tangential arcs to the halo of 46°, the parhelic circle, the para-anthelia of 60°, and the vertical columns or bright bands of light passing through the sun.

III.—When the plates of the ice crystals are vertical they produce the halos of 22° (the upper and lower parts of which are by far the brightest portions), the upper and lower arcs tangential to this halo, the lateral arcs tangential to the halo of 46°, and the parhelic circle.

IV.—When the lamellar crystals are unsymmetrically developed, so as to cause one of their diagonals to be vertical as they slowly fall through the air, they produce the extraordinary arcs tangential to the halo of 22°, the parhelia of 46°, the anthelia, the oblique arcs passing through the anthelia, and the similar arcs passing through the sun itself.

The relative frequency of these groups of phenomena, as indicated by the number of cases observed by Bravais, is:

I.—The great majority of cases.
II.—Two or three hundred times, or very frequent.
III.—Eighteen times.
IV.—Eight times.
II and III simultaneously.—Forty-five times.
II and IV simultaneously.—Three times.
III and IV simultaneously.—Once.
II, III, and IV simultaneously.—Six times.

THERMOMETER EXPOSURE.

It is frequently complained of the Weather Bureau temperatures that they relate to points in the atmosphere too high above the ground, and some remarks on this subject from our esteemed voluntary observer, Dr. A. C. Simonton, of San Jose, Cal., suggests the question, "What part of the atmosphere is of interest to man so far as temperature is concerned?" He answers this from the physician's point of view and says, "Evidently that part in which he lives." But to this we must add that man is also interested in a much wider range of temperature than this. We might even ask, "*Where* does man live? Does he wish the temperature at 5 or 6 feet above ground or at the surface itself? Does he wish it in the house or in the street; in the plowed field or in the forest; in the lowlands and ravines or on the highlands and plateaus; in the cool ocean breeze on the seashore or in the stifling hot air half a mile inland?" Evidently, there can be no restriction. The temperature of any special locality is of interest, but only when we are studying the phenomena of that locality. Even the reflected heat from a sandbank in the sunshine becomes of importance when we are studying the human life and the plant life that are subjected to it.

It was never supposed that the so-called regulation or standard instrument shelter would give us the temperature of the air at any of these special localities; thermometers placed therein give us very little idea of the nocturnal minimum temperature of the surface of leaves of grass and low tender garden vegetables, nor yet of the midday maximum temperatures of the surface of the soil. Special thermometers must be placed in special localities if we wish to know accurately these local temperatures. Thermometers whose bulbs are free to give and take radiant heat give us very little idea of the temperature of the air in contact with them because radiant heat passes through the air without affecting it very much, but it does affect the temperature of the bulb of a thermometer by nearly its full amount. It is, therefore, very nearly correct to say that a thermometer in the air indicates the average temperature due to the radiation between it and its material inclosure. If it is entirely surrounded by a shelter it gives the average temperature of the inside surface of that shelter. If its inclosure consists of grass or soil below it, trees and houses around it, clouds and blue sky above it, then the radiation between it and each of these affects it in proportion to their temperatures and the solid angles they subtend at its center. It would require a very strong wind or a violent whirling of the thermometer to produce enough convection of heat between it and the air to enable it to indicate a temperature that is even approximately close to that of the air. The so-called *ventilation of the thermometer* is the *first essential* in getting the temperature of the air and the *cutting off of all noxious radiation is the next essential*. As was explained in the Editor's "Treatise on Meteorological Apparatus and Methods," page 80, "The thermometer should neither give heat to nor receive heat from any object that has a temperature differing from that of the external air. When the thermometer is surrounded by a screen and fresh air is drawn into the screen, or blown in by the wind, it should show no change in temperature. When a thermometer is whirled rapidly in the free air, near the shelter, and at the same time protected from noxious radiations, it should give the same temperature as the thermometer within the screen." There are but two practicable ways of getting the temperature of the air at any given spot, viz, (1) let the thermometer be screened from radiation by placing it within one or two thin metallic tubes, and then whirling the whole combination rapidly, or (2) let the thermometer and screens be stationary and the air drawn rapidly over its surface and through the screens.

The temperature of the air is a very different matter from the temperature of a surface, whether it be a surface of soil,

rock, water, leaves, the human skin, or the outside surface of the clothing. The temperature shown by an accurate thermometer is always the average temperature of its bulb, but we are ourselves liable to make a mistake in assuming that this is also the temperature of the object that we wish to measure.

It is claimed that the nocturnal minimum temperature, as recorded within a shelter, is always higher than the real minimum temperature of the air, because the shelter retains the heat that it acquired during the day, and that therefore, the minimum thermometer should be placed outside the shelter, with a mere canopy above to prevent radiation to the clear sky. But if the shelter is properly made the heat of its top and sides, warming the cold air in contact with them, will cause the latter to rise, drawing in fresh air from all sides; if this indraft is strong enough it will keep the thermometers down to the temperature of the air, if it is not strong enough it must be increased by artificial aspiration or by whirling the thermometer; therefore, the Weather Bureau shelter, like that of all other modern meteorological offices, combines ventilation with screens that shelter from noxious radiations.

We regret very much that these modern improvements are too expensive to be provided for every important voluntary station. In this respect, however, all the world is on the same plane, and observers everywhere have to content themselves with the reflection that, although the maximum temperatures may be too low and the minimum too high, yet the average temperatures of the day, the month, and the year will not be very erroneous. Meteorology and climatology have not yet attained to that development as exact sciences that they can afford to dispense with the faithful work of an honest observer, even if there be small systematic errors in his work. Of course, those who can give us some idea of the amount of these errors, in their own individual cases, will contribute by so much to the advancement of exact knowledge.

FAKE STORMS.

Mr. John F. Smith, Jr., voluntary observer at Jasper, Hamilton County, Fla., reports that no storm occurred in that neighborhood during the current month corresponding to the one described in a special telegraphic dispatch published in a Cincinnati paper of July 19. Something like Farmer Harvey's race with a tornado may have occurred at some other time and place, but as it stands the record seems to be a hoax.

Meteorology is peculiarly liable to be troubled by the inevitable errors of observers, but it is greatly to be regretted that any one, in seeking to hoax the public, should not also send the Weather Bureau at least a word of caution. We rely so implicitly on the good faith of the press and of both regular and voluntary observers, that it troubles us to realize that we are liable to be taken in by such unblushing deception. Mr. Smith kindly suggests that the tornado in question may have happened in the neighborhood of Jasper, Walker County, Ala. (or, possibly, Jasper, Pickens County, Ga.), but we fear that it is not worth our while to make further search after this will-o'-the-wisp.

Whenever similar inventions appear in the daily press, we should be glad to have the local voluntary observer communicate directly to us a refutation of the misleading statement, in order that such romances may not unwittingly be quoted as belonging to the annals of science.

THE PRACTICAL UTILIZATION OF LIGHTNING.

If the study of atmospheric electricity is of general interest to meteorologists, then they must take an equal interest in its practical application to the wants of man. Franklin wrested the thunderbolts from the heavens, but no one has yet harnessed them to useful work. The telegraph and the telephone, the electric light and electric motors, illustrate our control of artificially manufactured electricity, but the natural article in its native state is still a terror to man, or an annoyance. For a generation past there have been innumerable schemes for the use of ground currents in telegraphy and aerial currents in telephony. The daily press announces that quite recently an inventor at Worcester, Mass., has perfected mechanism by which he can actually discharge a bolt of artificial lightning and control its direction, and again, we are told that "several experimentors are already employed in devising a plan for gathering and storing atmospheric electricity which may be employed for lighting, heating, and motor power."

A still more hardy inventor of the highest scientific attainments has arranged a trap to catch electro-magnetic waves from the sun, or other heavenly bodies, and although he has caught nothing, yet the idea is still held to be scientifically correct.

The fact is, however, that the natural electric and magnetic forces at the earth's surface are so vastly inferior to the forces of gravitation and solar heat, wind pressure, waterfalls, and even tidal rise and fall, that man can not profitably experiment with natural electricity while these greater forces are running to waste.

MOUNTAIN STORMS.

Referring to Mr. Struble's article on "Peculiar Mountain Storms," in the MONTHLY WEATHER REVIEW for May, 1897 (Vol. XXV, p. 212), Mr. A. D. Elmer, voluntary observer at Northfield, Mass., states, under date of July 31, 1897, that—

In the American Meteorological Journal for August, 1895, Vol. XII, p. 127, there will be found reprinted from the New York Tribune an account of local winds and clouds at New Lebanon, N. Y., which also may be considered as a perfectly reliable description of what obtains also at Northfield, Mass., under the same conditions, except that as the decline from the ridge of the eastern hills, over 1,500 feet above sea level, to the Connecticut River Valley, 200 feet above the sea, is less than the Taconic decline or the Laurel Hill decline in Pennsylvania, therefore the gale is not noticeable a mile from the mountain base, except in occasional gusts, and is not so strong at the base as to attract serious attention, not breaking limbs from trees, but manifesting itself from westward by a loud roar; otherwise the conditions in the three cases are practically identical, except, I think, by the "storm rarely reaching 6 miles west," Mr. Struble means the gale, etc., for the other manifestations of the general cyclone must present themselves there. As to explanation, it seems to me that as the chinook manifests itself in the same descending tendency, likewise the great guns of a West Indian hurricane, it may be assumed that all winds preceding a storm center, with falling barometer, represent air that is being forced down; therefore they flow down hill with accelerated velocity, similar to liquids, as water, etc. (Exception: When the increased temperature and lessened specific gravity of the storm current is sufficient to offset the pressure from above.) It is to be hoped that observations taken in the meteorological region—which is, strictly speaking, not less than the general height of clouds—will reveal the present mysteries in major part.

LANDSLIDE IN VERMONT.

We have received from Mr. W. A. Shaw, of Northfield, Vt., Weather Bureau Observer, an excellent manuscript map by E. J. Hatch, of Warren, Vt., showing the characteristics of the great landslide that occurred Wednesday, July 14. The previous landslide on record in this region is that of June 3, 1827, when about 100 acres slid from Fayston Mountain down to the valley beneath. The worst flood in the history of the valley was in July, 1830, and again July, 1850, and October, 1869. The landslide of the present month had been preceded by heavy rains, but it seems to have been started by the fall of an immense boulder near the top of the mountain in the northwest corner of Warren township at an altitude of about 3,890 feet. Simultaneously, another slide began at a point a little south of this boulder; the two slides joined together after a path of about 100 rods, and the com-

bined avalanche continued not only three miles eastward to the foot of the mountain, but a mile farther over comparatively level ground. About 120 acres of heavily wooded spruce timber went down in the slide, leaving the rocks behind almost perfectly bare. The average width of the avalanche was about 20 rods, and at several points at the top of the slide it was at least 60 feet deep. In passing over the old landslide of seventy years ago, half way down the valley, it tore out the logs, rocks, and débris that had been then deposited. The foot of the slide now covers an area of nearly a quarter of a mile square, on land that is about 1,300 to 1,478 feet above sea level, making an actual fall for the whole mass of about 2,400 feet. The slide apparently ran down the ravine occupied by Clay Brook and landed at its mouth in the valley of the Mad River, latitude 44° 8′ north, longitude 72° 50′ west.

THE ORIGIN OF THE ST. LOUIS TORNADO.

Mr. M. C. Walsh, of La Salle Institute, Glencoe, Mo., under date of December 31, 1896, says:

I saw the formation of the tornado, May 27, 1896, which went into St. Louis from the southwest. Two long, heavy black masses of cloud, one moving from the southwest, the other curving from the northeast, having been drawn away from a column moving in a northeast direction, met at the height of about 1,000 feet over the plain, in front of Glencoe; there was a great tossing, the southwest column plainly bellying into the one from the northeast; a whirling was soon discernible; its rapid motion was seen from the small white masses of vapor that were thrown off and which seemed to be trying to catch on; presently the inverted funnel with the long, black, rugged tail appeared, and then the whole mass moved off northeastward, leaving a heavy bank of white connected clouds in the southeast, the only remnant of the great black mass that had come from the southwest. I said, "St. Louis will catch it now." The whole black mass was whirled away with the greatest rapidity. The twister got to the ground near Kirkwood, on the Southern Pacific Railroad, about 14 miles from the place of its formation.

FROST FORMATIONS.

A letter from Prof. E. E. Hand, of the South Division High School, Chicago, Ill., referring to the MONTHLY WEATHER REVIEW for May, page 213, says:

I had made various observations on the forms which Mr. Valerio so graphically describes, while I was teaching at Kuttawa, Ky. I have never found any one who has seen them nor any reference to them in print, so I have been unable to determine whether we had here a problem in biology or meteorology to solve. My conclusion was, since I found the frost ribbons only on the dittany (*Cunila Mariana*), that there was some peculiar exhalation from this herb that froze as it came out. Of course I may be wrong, as my observations were limited, and I have never seen it in Illinois. I shall be pleased to hear from other observers on the subject.

In addition to the previous references to articles in the American Meteorological Journal, perhaps the most interesting reference is to the article by Prof. John Leconte, pp. 20 to 34 of the Proceedings of the American Association for the Advancement of Science, Vol. III, March, 1850. According to him these interesting frost formations occur on a large variety of plants, and can hardly be considered as biological phenomena. The explanation given by Professor Leconte, in connection with that suggested by the Editor in the American Meteorological Journal, Vol. IX, p. 523, April, 1893, will, it is hoped, serve as a starting point for laboratory experiments and the complete elucidation of these frost formations.

MEXICAN CLIMATOLOGICAL DATA.

Through the kind cooperation of Señor Mariano Bárcena, Director, and Señor José Zendejas, vice-director, of the Central Meteorologico-Magnetic Observatory, the monthly summaries of Mexican data are now communicated in manuscript, in advance of their publication in the *Boletin Mensual;* an abstract translated into English measures is here given in continuation of the similar tables published in the MONTHLY WEATHER REVIEW during 1896. The altitudes occasionally differ from those heretofore published, but no reason has been assigned for these changes. The barometric means have not been reduced to standard gravity, but this correction will be given at some future date when the pressures are published on our Chart III.

Mexican data for July, 1897.

Stations.	Altitude.	Mean barometer.	Temperature.			Relative humidity.	Precipitation.	Prevailing direction.	
			Max.	Min.	Mean.			Wind.	Cloud.
	Feet.	Inch.	° F.	° F.	° F.	%	Inch.		
Arteaga (Coahuila)	......	......	87.4	64.6	80.6	......	5.63	......	......
Colima	1,656	......	......	......	80.4	......	......	......	......
Culiacan	112	29.67	98.6	66.2	88.2	62	2.88	w.	w.
Durango (Seminario)	6,241	24.10	91.4	59.0	75.2	52	6.48	......	e.
Leon	1,798	24.34	83.5	55.2	68.2	67	8.30	ssw.	e.
Linares	1,188	......	101.8	66.2	84.4	......	0.98	se.	......
Magdalena (Sonora)	1,508	......	91.9	75.9	85.3	......	3.15	sw.	n.
Merida	50	29.95	96.8	69.6	81.5	78	4.90	e.	e.
Mexico (Obs. Cent.)	7,472	23.10	77.2	53.6	63.0	68	5.10	nw.	ne.
Mexico (E. N. de S.)	......	23.06	81.1	51.8	65.7	69	3.74	nw.	......
Monclova (Coahuila)	1,926	......	100.4	71.6	87.4	......	1.10	......	......
Monterey	1,626	28.18	103.1	68.0	86.2	62	0.48	ne.	ne.
Morelia (Seminario)	6,401	24.00	75.2	50.2	61.0	77	4.18	ssw.	se.
Oaxaca	5,164	25.10	87.1	55.4	71.2	74	5.32	nw.	e.
Parras (Coahuila)	3,986	......	95.9	68.4	79.5	......	0.83	...?...	......
Puebla (Col. Cat.)	7,112	23.40	79.5	51.8	64.4	72	8.75	e.	n.
Queretaro	6,070	24.21	84.2	56.7	68.5	64	4.90	e.	......
Saltillo (Col. S. Juan)	5.399	24.80	95.0	62.2	76.6	53	1.06	ne.	ne.
San Luis Potosi	6,202	24.16	82.0	58.3	69.3	65	1.85	e.	se.
Silao	6,063	24.30	80.2	61.7	70.5	68	4.46	se.	ne.
Toluca	8,612	21.95	72.9	46.4	59.5	75	6.18	ese.	......
Torréon (Coahuila)	3,720	......	104.2	75.6	86.4	......	5.32	......	......
Trejo (H. d. S., Gto.)	......	......	81.5	......	......	......	8.00	se.	......
Vaqueria	......	......	90.3	61.3	72.0	......	8.07	......	......
Zacatecas	8,015	22.57	77.9	50.0	62.4	69	8.82	e.	e.
Zapotlan (Seminario)	5,078	25.10	83.1	58.8	71.1	69	9.21	se.	se., ne.

CLIMATOLOGICAL DATA FOR JAMAICA, W. I.

Through the kindness of Mr. Maxwell Hall, of Montego Bay, Jamaica the meteorological service of that colony has acceded to the request of the Editor for the prompt communication of an abstract of the very interesting climatological records of that highly important West Indian station. The climatological summary for July, 1897, furnished by Mr. Hall through his assistant, J. F. Brennan, of the Meteorological Office, is reproduced in the following table.

The stations Kings House, Hope Gardens, and Stony Hill Reformatory are near Kingston, and are not supplied with mercurial barometers. The barometric pressures, as given for these Jamaica stations, are reduced to the standard instrumental temperature (32° F.) and standard gravity (latitude 45° and sea level), and all except Hill Gardens are also reduced to sea level. The thermometers are exposed in Stevenson screens, and their readings have been corrected for instrumental errors. The wind movement is measured by Robinson anemometers, assuming the factor 3. The amount of cloud is given in tenths of the whole sky; the lower clouds are for the most part fracto-stratus; the middle clouds, cumulus; and the upper clouds, cirrus or cirro-stratus.

The observations at 7 a. m. and 3 p. m. at Kingston and Hill Gardens are also communicated in detail by Mr. Hall, but are not published at present, although eventually this may be done, as Hill Gardens is, like Blue Mountain, an interesting mountain station, for comparison with its near neighbors, Castleton Gardens and Kingston. If a mountain summit station can be obtained this also will be published. Many details with regard to the climate of Jamaica will be found in Mr. Hall's contributions to the official handbook published by the Government of that island in 1881.

The important mutual relations between the meteorology of the West Indies and the southern portion of the United States must stimulate the study of these records from Jamaica.

Jamaica, W. I., climatological data, July, 1897.

		Morant Point Lighthouse.	Negril Point Lighthouse.	Kingston.	Kings House.	Castleton Gardens.	Hope Gardens.	Stony Hill Reformatory.	Hill Gardens (Cin. Plant.)
Latitude		17°56′	18° 16′	17° 58′	......	18° 12′	......	......	18°05′
Longitude		76°10′	78° 23′	76° 48′	......	76° 50′	......	......	76°39′
Elevation (feet)		8	33	50	400	580	600	1,400	4,907
Mean barometer	7 a. m.	29.955	29.959	29.965	......	......	......	......	25.248
	3 p. m.	29.923	29.927	29.918	......	......	......	......	25.192
Mean temperature	7 a. m.	......	78.9	77.5	73.7	73.0	......	73.3	63.0
	3 p. m.	......	83.4	86.2	86.8	83.1	......	80.1	67.4
Mean of maximum		......	87.2	89.1	91.2	86.6	......	85.9	71.5
Mean of minimum		......	72.6	73.5	66.8	67.8	......	65.9	59.3
Highest maximum		......	90	92	96	91	......	90	75
Lowest minimum		......	70	71	63	60	......	65	56
Mean dew-point	7 a. m.	......	72.7	69.4	70.7	69.6	......	69.8	57.8
	3 p. m.	......	74.7	72.5	77.9	75.8	......	74.2	62.1
Mean relative humidity	7 a. m.	......	82	77	96	85	......	89	83
	3 p. m.	......	75	65	74	77	......	82	84
Monthly rainfall (inches)		3.07	9.00	1.74	2.80	5.95	2.89	4.11	2.02
Average daily wind movement		......	217.2	94.6	......	......	......	......	17.9
Average wind direction	7 a. m.	ne.	n. e.	n.	......	......	......	......	......
	3 p. m.	ne.	e.	se.	......	......	......	......	......
Average hourly velocity	7 a. m.	5.0	6.5	1.0	......	......	......	......	......
	3 p. m.	7.0	10.4	7.3	......	......	......	......	......
Average cloudiness (tenths):									
7 a. m.	Lower clouds	2.5	0.2	1.0	......	......	......	......	......
	Middle clouds	2.5	0.8	0.6	......	......	......	......	......
	Upper clouds	1.2	5.4	3.2	......	......	......	......	......
3 p. m.	Lower clouds	2.8	4.2	2.6	......	......	......	......	......
	Middle clouds	1.8	3.9	1.3	......	......	......	......	......
	Upper clouds	1.4	0.8	3.6	......	......	......	......	......

For the summit of Blue Mountain at an elevation of 7,423 feet, the rainfall for July is 5.15.

In a note on the "Jamaica Weather Report for the month of June, 1897," Mr. J. F. Brennan shows that on the average for the whole island the rainfall for the current year has been as follows:

Months.	Normal.	1897.	Excess.	Accumulated excess.
	Inches	*Inches.*	*Inches.*	*Inches.*
January	4.09	0.32	− 3.27	− 3.27
February	2.64	0.69	− 1.95	− 5.22
March	3.01	1.82	− 1.19	− 6.41
April	4.61	7.52	+ 2.91	− 3.50
May	9.57	11.57	+ 2.00	− 1.50
June	8.21	5.23	− 2.98	− 4.48

EARTHQUAKE-PROOF BUILDINGS.

The great anxiety felt by those who live in countries subject to earthquakes has stimulated the application of our knowledge of seismology to the construction of buildings that shall be approximately proof against injury from earthquakes. The idea that it was possible to do this was defended by the English engineer, Mallet, who published a work on the dynamics of earthquakes in 1846, and whose views became especially popular after his elaborate report on the Neapolitan earthquake of 1857. He showed that the destruction of brick or stone buildings depended upon the way in which the elastic wave of compression issued from the crust of the earth, or rather upon the way in which the base of the building moved, while its top, by reason of its inertia, resisted motion. Of course the strain broke the building in its weakest joints, usually those of poor mortar, but often the weaker stones. From the cracks in the building, Mallet attempted to determine the nature of the shock and the origin of the earthquake, which he generally located between 3 and 10 miles below the earth's surface. Mallet established certain principles according to which buildings may be constructed, so that they shall be able to resist any shock that is likely to visit them, and his views have been applied to the construction of lighthouses, customhouses, and other important buildings. But since those days American engineers have devised a new style of building that was entirely unthought of in Europe twenty years ago, so that we now have four principal types of tall buildings that can withstand the ordinary shocks of earthquakes, viz:

1. Buildings of wooden or bamboo framework, where the parts are so bound together that the whole can sway to and fro like the masts of a vessel at sea.

2. Most solid masonry walls, whose bases are much broader than their summits, the walls and joints having a slope such that the emerging blow of the earthquake shock is likely to strike the joints at a safe angle.

3. Those in which the walls merely support their own weight, while the floors rest independently on their own columns of brick or, still better, of iron.

4. The so-called steel balloon frame, of steel columns and beams and girders, whose panels are filled in like a wall of brick or stone and whose floors are of brick and cement. The steel beams and columns are bound together as firmly as is the wooden framework in class No. 1, and the whole sways to and fro like an elastic mass.

THUNDERSTORMS IN FRANKLINVILLE, N. Y.

The Editor has received from Dr. John W. Kales, voluntary observer at Franklinville, Cattaraugus Co., in western New York, the following description of the remarkably numerous thunderstorms that occurred in that region during the current month, and which seems worthy of record as illustrating one extreme feature of our climate:

The month of July was remarkable for the number of thunderstorms, excessive rainfall, high temperature, and damage caused by lightning.

The station is in a valley surrounded by hills from 400 to 600 feet high. It is 1,598 feet above sea level, in latitude 42° 20′ N., longitude 78° 29′ W. The valley is about 1½ miles wide (in fact an old lake bed) 30 miles long, and extends northeast by southwest. An elevated plateau, about 500 feet high, lies southwest. The prevailing winds are southwest. The thunderstorms occurred as in the following table:

Date.	Time of beginning.	Time of ending.	Rainfall.	Direction of wind.	Max. temperature.	Remarks.
2	11:00 a. m.	2:00 p. m.	.14	nw.	81	
4	4:00 p. m.	5:00 p. m.	.04	s.	96	Highest temperature on record here.
5	2:00 p. m.	1:00 a. m.	1.21	s. veered to nw.	94	Three people injured, 1 killed; house wrecked by same flash of lightning at 5 p. m.
10	6:30 p. m.	6:30 p. m.	.00	s.	93	Distant thunder in northeast.
11	3:00 p. m.	10:00 a. m.	2.00	sw. veered to n.	88	Tornado and hail.
13	7:00 p. m.	7:00 p. m.	T.	s.	78	Distant thunder in west.
14	8:00 p. m.	4:30 p. m.	.26	w.	72	Distant thunder at 2 p. m., west.
18	7:00 a. m.	....	.01	s.	83	Thunder at 3 p. m.
19	2:00 p. m.	3:30 p. m.	.76	s.	82	.51 inch rain fell in 12 minutes.
20	9:00 a. m.	3:00 p. m.	.21	s.	81	Hail.
22	During	night	.14	se.	84	Thunder at 5 p. m.
23	2:00 a. m.	4:00 p. m.	.32	w.	73	Thunder at 2 p. m.
26	Rained	3 days	......	s.	80	Thunderstorm at 6 p. m.
30	5:45 p. m.	6:45 p. m.	T.	w.	81	
31	10:00 p. m.	10:00 p. m.	.00	w.	75	

Of the fifteen thunderstorms that of the 5th was remarkable. It appeared to form in the hills to the southwest. Enormous masses of black clouds formed, thunder rolled without cessation and shook the hills. Streams of lightning played along the crests of the hills for miles. At 5 p. m. a flash extended across the southwest horizon more than 90°. This flash of lightning injured 3 persons at Ischua, 6 miles distant; killed a child at Sugartown, 6 miles distant; and wrecked a dwelling at Ashford, 10 miles away. These three places are in a line extending across the elevated plateau.

On the 11th another thunderstorm formed in the hills west of the station, and at 3 p. m. came through "the narrows" (an opening in the hills half a mile west of the station), where it developed into a tornado. Here a strong southwest wind caught the storm and swept it up the west side of the valley in plain view. The loud roar was plainly heard as the wind swept along the hillsides. Lightning fired a barn, burned another, knocked a chimney off a house, and shivered trees. The wind uprooted trees in its course, and changing to north, drove the storm down the valley again. At 2 p. m. on the 19th a dark

cloud formed in the southeast and passed directly over the station. At 3 p. m. a terrific peal of thunder, without visible lightning, occurred. This was followed by rain. In twelve minutes 0.51 inch of rain fell. Then a second peal of thunder occurred, not as loud as the first. The rain ceased, and in a few moments the sun was shining in noonday splendor. On the 20th a black cloud formed in the north and a similar cloud formed in the northwest. These clouds met on the hills west of the station and 450 feet above it (measured by barometer). When they met, hail commenced to fall, at 3 p. m., and continued about half an hour. The hail lay inches deep on the ground and remained into the night. Some people gathered hail by the pailfull and froze ice cream with it. This hail and that of the 11th damaged growing crops and thrashed growing peas. During a residence of thirteen years I have not observed a similar month of thunderstorms, and have no desire to see it repeated.

RECENT EARTHQUAKES.

On June 20, 1897, at 8:30:29 a. m., at Port au Prince, an earthquake shock. At first a horizontal stroke coming from the east, and two seconds afterward a stroke from the northeast, lasting three seconds. After an interval of two seconds a nearly vertical shock occurred, followed by another of the same character but less intense. At 8:31:30 a last feeble, horizontal shock came from the north. Small movements of the earth were indicated by the Bertelli tromometer until 9 a. m. The preceding data are taken from the curves traced by the Cecchi seismograph and are communicated by Dr. P. J. Scherer, director of the observatory at Port au Prince, Hayti, in connection with his meteorological report for this month. (The observatory is located at N. 18° 34′, W. 71° 21′; altitude, 37.20 meters.)

July 25, Castle Pinckney, slight. [This may be the same as the following.—Ed.]

July 26, San Francisco, 5:40 p. m. (8:40 eastern time) a sharp, short, and heavy earthquake, preceded by a low rumbling sound. No damage is reported. At the Weather Bureau office, in the Mills Building, Mr. A. G. McAdie registered the time as 5:40:35; the trembling lasted about two seconds; the motion was apparently in a vertical direction.

KITES AT THE CHICAGO CONFERENCE, AUGUST, 1893.

In previous pages of the MONTHLY WEATHER REVIEW the Editor has collected a number of items illustrating the early use of the kite for meteorological investigations. The recent development of this subject can, probably, only be written after searching through many popular and technical journals. In order to assist our readers, and to complete our collection of data on this subject, the Editor will occasionally review the items published in some of these journals.

The International Conference on Aerial Navigation, held in Chicago, August 1–4, 1893, under the auspices of the Columbian Exposition, seems to have originated in a suggestion by Prof. A. F. Zahm, of Notre Dame University, in Terre Haute, Ind., and forms an important epoch in the history of the use of the kite in America. The proceedings of this conference were published in a series of papers appended to the American Engineer and Railroad Journal, but which also appeared separately, as Vol. I of Aeronautics, a proposed periodical which, however, stopped with No. 12 of that volume, which was published in September, 1894. They were rearranged and printed in a volume of proceedings, in 1895. The conference, and the wide publication of its proceedings, owes its success largely to the devotion of the famous Engineer, Mr. Octave Chanute, of Chicago, who was chosen chairman, and Prof. A. F. Zahm, who was chosen secretary of the committee, to organize and carry out the project.

The attendance at each session comprised about 100 persons who seemed to take great interest in the proceedings, and discussions brought out several investigators who had been studying the subject or trying interesting experiments without making it publicly known.

The following items referring to kites are taken from Vol. I of Aeronautics; the rest of that magazine is mostly occupied with discussions relative to flight by birds and aeroplanes, the pressure of the wind on inclined surfaces, and other correlated matter.

On page 43 will be found the memoir of Prof. Langley on "The Internal Work of the Wind," which had been read by title in April, 1893, but now in full at this meeting of the International Conference, where it excited great attention and discussion. Among the items brought out in the discussion of this first publication of this memoir were the interesting communications from Professor Marvin, page 87, and Professor Zahm, page 99.

The gustiness of the wind has been an object of study for the past two centuries, but it was reserved for the professors of the Weather Bureau to show that, inasmuch as we do not measure gusts with an apparatus that has no inertia, we must, therefore, attempt to compute the gusts and their effects by the use of several anemometers simultaneously that differ among themselves only in their inertia. Professor Marvin, therefore, had in 1888 devised and constructed several forms of light paper hemispherical or conical cups, such that the moment of inertia of the revolving mass was but a small fraction of that of the ordinary metallic anemometer. He also introduced the aluminum cups whose moment of inertia is quite small. With such apparatus he determined the effect of gustiness on the ordinary anemometer records, both at the City of Washington and on the summit of Mount Washington, and deduced the formula and tables, published by the Weather Bureau in 1889 and recommended for ascertaining the true velocity from that indicated by the Robinson anemometer. These ingenious paper cups and the results of Marvin's work, being known to the late Mr. G. E. Curtis of the Weather Bureau, had by him been brought to the notice of Professor Langley, who, through the Chief of the Weather Bureau, obtained Professor Marvin's apparatus for use in his observations, as detailed on page 45 of Langley's memoir. To the present Editor it seems that, in order to measure the gusts which affect kites and do such great destruction in tornadoes, we must employ either the suction anemometer, as was explained in his lectures of 1882, and his Treatise of 1887, or the paper apparatus constructed by Professor Marvin, and described by him in the American Meteorological Journal, April, 1889, Vol. V, page 556. In general, the less the inertia of the measuring apparatus is called forth so much the shorter and more violent are the recorded gusts and variations in the wind—at least near the surface of the ground where measurements must be taken; but the infinite irregularity of these gusts and eddies can best be perceived by watching the flotation of motes in the sunbeam in still air, or thistle down and snowflakes in ordinary winds.

On page 71 Mr. Carl Myers, of Frankfort, N. Y., states that—

I constructed some kites with a flexible backbone and which when released would advance relatively against the wind, that is, they would not drift back as fast as the wind blew. An account of some of these kite experiments will be found in the Scientific American Supplement (No. 835) for January 2, 1892.

On page 72 Prof. J. B. Johnson, of Washington University, St. Louis, states his belief that the gusts recorded by Professor Langley are not typical, and explains how he has "tested the gustiness of the ordinary atmospheric movements by observing the column of smoke from a tall chimney."

On page 82 Mr. William A. Eddy, of Bayonne, N. J., in a letter dated January 11, 1894, describes the "soaring aeroplane kite." He states that he—

Had heard of the buoyancy of the malay kite, but was unable to get measurements showing its construction, when in 1890 he began the

difficult task of reinventing it. He first saw the original type of this kite in the Javanese village at the Columbian Exposition in August, 1893, and then found that, after three years of experiment, he had evolved a kite like the original, but with a higher cross stick bent backward and downward like a bird's wing that has completed the upward stroke in flying. This last improvement was made at the suggestion of Mr. Charles L. Flanders, of New York, who had made and flown a malay kite at Cape Town, South Africa. The kite at the Javanese village resembled a model which I had discarded because of its insufficient steepness in ascending. The malay calm kite will rise and remain up in a dead calm layer of air only when the person holding it walks at the rate of 2 or 3 miles per hour, but it will reach and penetrate the lower cumulus cloud strata in a 3-mile wind, if flown tandem. Usually a calm precedes the moment when the wind is about to suddenly reverse. * * * With the sudden cessation of all wind, the malay kite releases its tension upon the string holding it, which then hangs straight down beneath the kite. * * * If pulled in rapidly in a calm the kite not only reaches the zenith in a position nearly horizontal to the earth, but progresses on beyond the zenith, owing to its momentum, and then again makes a long descent. * * * The convex under surface of this kite presents an important condition of aerial flight.

Page 99, Prof. A. F. Zahm, of Notre Dame, Terre Haute, Ind., describes the studies made by himself and his brother, Prof. J. A. Zahm, of the same university, on the behavior of the wind. He constructed a universal anemoscope, whose vane was so pivoted on horizontal and vertical axes as to be free to point in all directions. The azimuth and angular altitude of the vane was recorded continuously, together with the horizontal velocity of the wind, but finding that the Robinson cups used by the Weather Bureau possessed too much inertia, he tried the aluminum screw-anemometer constructed by Richard Bros., with results similar to those of Marvin, Fergusson, and Langley. He says:

While at the Johns Hopkins University, in the spring of 1893, I employed an exploring line to indicate to the eye the waves of a changeable air current. It consists of a strong, fine thread, having attached to its extremity a small rubber balloon, inflated just sufficiently to fairly float. When paid out in a breeze, the balloon rises and falls with every billow, like a cork on the water, and the line itself is bent into waves, sometimes of monstrous size, thus enabling one to form a conception of the actual billows of the atmosphere.

I do not mean to assert that the direction of the line accurately portrays the direction of the wind at all its parts, for the pull of the balloon tends to straighten the line, but I am sure that it does not give an exaggerated indication, because the pressure of the wind must always be against the concave parts of the line; hence the wind's course must be even more wavy than the line itself. If the main exploring line had along its length a number of short branch lines, each tipped with a small balloon, the branches would point out the direction of flow in their immediate locality.

After some preliminary tests from the top of the physical laboratory of the Johns Hopkins University, during the Easter vacation of 1893, I ascended the Washington Monument at Baltimore, where I paid out the exploring line at a height of 200 feet. The wind was blowing toward the southeast at the speed of 25 to 35 miles per hour, and the sky, which had remained clear till 3 o'clock, was rapidly darkening, with indications of approaching rain. The balloon when let forth immediately fell to a depth of 30 or 40 feet, being caught in the eddy of the monument, then presently encountering the unbiased current, sailed in it toward the southeast, approximately level with the spool end of the thread. After the balloon had drawn out 100 feet of thread, I checked it to observe the behavior of this much of the exploring line. The balloon rose and fell with the tossing of the wind, but did not flutter like a flag, as it would do if formed of irregular outline. Neither did the thread flutter, nor do I believe there is ever a tendency in a line to greatly flutter in a current as does a flag or sail. Presently I paid out 300 feet of the exploring line, whereupon the waves in the thread became quite remarkable. The thread, then, as a rule, was never approximately straight. Sometimes it was blown into the form of a helix of enormous pitch, at other times into the form of a wavy figure lying nearly in a single vertical plane, and again the entire exploring line would veer through an angle of 40° to 60°, either vertically or horizontally. The balloon would, of course, seldom remain quiet for more than a few seconds at a time, but tossed about on the great billows like a ship in a storm. Quite usually the billows could be seen running along the line from the spool to the balloon, and, as a rule, several different billows occupied the string at one time.

The observations just delineated, however curious they may be, afford no adequate conception of the behavior of the air currents over an open plain nor at a great height above the earth, because the Washington Monument of Baltimore stands but 100 feet above the surrounding buildings, which undoubtedly send disturbances to a greater height than 200 feet. To supplement these explorations, therefore, I determined to have them repeated from the top of the Washington Monument at Washington and the Eifel Tower at Paris.

Toward the latter part of the Easter vacation I again let forth the exploring line from the top of the Washington Monument, at Washington, at a height of 500 feet. A stiff breeze was blowing from the northwest and as the locality is quite free from obstructions everything seemed favorable for an exploration of the free air. But, unfortunately, I had not taken into consideration the enormous magnitude of the monument and of the consequent eddies surrounding it. Accordingly, when the balloon was let forth from one of the windows it was involved in a large and violent eddy from which it could in no manner be extricated. Rising vertically upward from the window to a height of some 25 feet it encountered the direct current and sailed toward the southeast with great rapidity to a distance of 30 or 40 yards, then suddenly turned to the right, being caught in a mighty whirlpool which sucked it downward through an enormous spiral path to a depth of 100 feet, and again threw it upward to the top of the monument, thus returning it quite near to my hand. After witnessing these evolutions for 10 minutes I was obliged, by the lateness of the hour, to return to the elevator without having observed the behavior of the exploring line in a direct current. I saw, however, what precautions would be advisable to insure the success of a second attempt.

The above rather long quotation gives us a very beautiful picture of the behavior of the vortices in the rear of an obstacle, but still fails to tell us to how great a distance from the obstacle these influences are felt. In his "Preparatory Studies" the Editor has quoted an observation of as many as seventeen vertical, cylindrical vortices, arranged in a row for several miles to the leeward of a tall chimney, and in his "Cloud Observations at Sea," he has shown how a series of clouds, representing the summits of horizontal rolls or waves, stretches for 50 miles to the leeward of Green Mountain on the Island of Ascension. In attempting to send up small hydrogen balloons for the determination of the wind velocity at sea, the Editor found that when liberated from the deck of a sailing vessel the balloons spent a long time entangled in the eddies in the rear of the sails and after finally escaping from these pursued an irregular path that demonstrated the far-reaching influence of these eddies.

On pages 106–107 Mr. J. Bretonnière describes the peculiarities of the wind, as observed by him at Constantine, Algeria. This city occupies a deep depression, and a line of high points passing through the city forms a barrier against the prevailing winds and produces a series of eddies, by means of which he was able to explain the flight of birds; great ascending and descending currents, as well as deflections to the right and left and rotating eddies, both stationary and traveling, filled the atmosphere to a height of at least 1,500 feet above the ground. Among the numerous detailed examples of local currents described by Bretonnière, we quote the following:

I saw one day a long and narrow object, resembling a rumpled newspaper, rise from the point of which I have just spoken, and above which some soaring bird had just been ascending. This object rose by fits and starts rapidly, in a direct vertical line in which it was suspended, with its length vertical. When it arrived at the height of about 300 meters, it was caught by a horizontal current and carried to another point, where it fell swiftly. I think that the newspaper occupied during its ascension the axis of a whirlwind. * * * In a few words, the greater inequalities of the ground transform the lower layers of the prevailing winds into ascending currents, and these, sometimes by their mutual reactions or by the action of the generating winds upon them, give rise to new currents more markedly ascending, or to whirling winds, or to whirlwinds.

The application of his numerous observations to the flight of birds are very full and clear, but do not belong to our present subject.

On page 112 it appears from a review of a work entitled Aeronautics, or an abridgment of aeronautical specifications filed at the British Patent Office from 1815 to 1891, that the aeroplane and its mechanical properties were first clearly presented by William S. Henderson, in 1842.

On pages 117–120 Mr. E. C. Huffaker, of eastern Tennessee, gives a number of minute observations on the wind and cur-

rents around the ridges and hills of that region and their connection with soaring flight.

Page 126, Mr. W. S. Bates, of Chicago, describes the kite used by Capt. Sir Georges Nares to carry a line ashore in case of shipwreck. The figures are reproduced from Captain Nares' work on seamanship; and the Nares kite seems to be similar in principle to the malay kite. It soars horizontally in the air, as if the wind were obliquely upward instead of horizontal; it consists essentially of a midrib and two triangular pieces of cloth, which slope from the midrib backward, but are kept apart by a cross stick at the rear.

On page 138 is the famous paper by Lawrence Hargrave, of Sidney, N. S. W., and the introductory remarks by A. F. Zahm, secretary of the conference. This seems to have been the first opportunity that Americans had to see and appreciate the cellular kite of Hargrave. These published proceedings and a subsequent paper by Hargrave in 1895 indicated the superiority of the Hargrave kite over the malay and started Professor Marvin in that line of research which is now producing such interesting results for meteorology. The complete details of Hargrave's labors during the past two decades are published in the Proceedings of the Royal Society of New South Wales. A condensed account is likewise given in Mr. Chanute's work, Progress on Flying Machines, and in the columns of the American Engineer and Railroad Journal for May, September, October, 1893.

Hargrave's experiments on the form of the kite were originally prompted by the desire to ascertain the best disposition of supporting surfaces in his flying machines. He says:

The novelty, if any, consists in the combination of two well-known facts: 1. That the necessary surface for supporting heavy weights may be composed of parallel strips superposed with an interval between them (described by Wenham in 1866 and adopted by Stringfellow in 1868). 2. That two planes separated by an interval in the direction of motion are more stable than when conjoined (patented by Danjard in 1871). The form which the complete kite assumes is like two pieces of honeycomb fastened on the ends of a stick, the stick being parallel to the axes of the cells. The cells may be of any section or number. The rectangular cells are easiest to make, and if the stick or strut between the two cells is placed centrally it is immaterial which side of the kite is up. Practically the top or bottom is determined by imperfections in the construction. The rectangular form of cell is, also, collapsible when one diagonal tie is disconnected. These kites have a fine angle of incidence, so that they differ from the kites of our youth, which we remember floating at an angle of about 45°, in which position the lift and drift are about equal. The fine angle makes the lift largely exceed the drift and brings the kite so that the upper part of the string is nearly vertical. Theoretically, if the kite is perfect in construction and the wind steady, the string could be attached infinitely near the center of the stick and the kite would then fly very near the zenith. It is obvious that any number of kites may be strung together on the same line, and that there is no limit to the weight that may be buoyed up in a breeze. * * * If a string of kites gets into contrary currents of air the kites and suspended weight may be disconnected from the earth and will remain supported, drifting in a resultant direction, determined by the force of each current and the number of kites exposed to it. * * * A kite whose horizontal surfaces are curved with the convex sides up pulls about twice as hard on the string as one of equal weight and area with plane surfaces.

On pages 152–153 Mr. William A. Eddy, of Bayonne, N. J., gives an account of his experiments with hexagon kites and tailless kites. He says:

In 1890 I began experiments to determine the relation between the width and length of the ordinary kite. My object was to evolve the best form of kite to be used in raising self-recording meteorological instruments to a great height, because many important problems in meteorology would be affected by investigations of the upper air currents.

I first found that a narrow kite would not remain well in the wind. It made a swift movement downward to the right or left, while a short broad kite, if properly weighted with tail, would fly well. It was evident that greater lifting power and kite surface could be obtained by filling in the points of the well-known six-pointed star kite, thus making a hexagon or six-sided kite. The lifting power and steepness with which the string reached up to the kite were remarkable. In certain winds this kite might have approached the zenith had not the weight of the tail held it back. This lifting power suggested the possibility of attaining great altitudes with a large kite. But a very large kite must be flown with a heavy rope throughout, while if other kites were attached to a main line then heavy rope would be required near the earth's surface only. In putting the lighter line aloft there is an obvious saving of weight as well as of power to withstand the strain of additional kites. * * * The limit of altitude attainable by means of tandem kites is yet to be determined. The 1891 experiment convinces me that if several miles of twine were extended upward into space the steep slant of the line could be maintained by increasing the size and number of the kites. With 10 miles of line and 50 kites from 2 feet to 8 feet diameter, an altitude of 4 miles ought to be reached, unless the rarefied air should fail to exert sufficient pressure. * * * When the tandem strings of kites are flying I have often noticed astonishing variations in the directions of air currents. Once when a string of kites was very high I observed that the upper kites described a sharp angle of direction as related to the lower, and when the kites were drawn in this sharp angle disappeared as the earth was approached. In case an altitude of 6 miles were reached, this variation in current might imperil the main line of kites by carrying all the upper ones away from the lower in an opposite direction. The variation in air currents may be a serious obstacle at times, but my experience during several hundred kite ascensions, both with and without a thermometer, is that a reversed current is exceptional if the kites are high in the air. I have observed only two reverse movements during two years at Bayonne, and these were at the surface. * * *

In time I think the malay kite will attain an altitude equaling that of the highest balloon ascensions at a relatively small cost, and that it will remain with its recording instruments several days in the *cirrus* clouds at a height of 9 miles. This may call for many decades of experiment. A balloon floats and drifts away and endangers life, but a kite, or a line of them, will remain nearly stationary and enable self-recording instruments to give us invaluable data at a great height above a local point, and during hours, and possibly days. The law of the upper air movements can be mastered only by an incessant waste of kites, owing to breakage and loss. At present great heights can be reached only during daylight; and if time is lost in adjusting kite tails to various wind velocities, then night may come on and the experiment be further delayed by the necessity of attaching lanterns to the strings below the kites. With a strong tandem line of large kites perpendicular cords can be run up to an upper kite and the instruments raised and lowered unless the altitude is too great.

At twilight during July and August I have many times noticed that while no wind was moving near the ground, yet the lower clouds were moving rapidly. With a long string laid along the ground to the kite I have, by walking slowly backward, raised the malay kite to an upper current during a calm at the surface. The vertical thickness of a mass of sluggish air may be often penetrated, yet when the calm air extends to a considerable height it may be difficult to get above it. A rapid walk of two miles would doubtless bring success, particularly at twilight in summer when the night winds set in. The vertical thickness of calm air may be sounded upward to a great distance by rapid motion at the surface. At night in summer the upper winds are steady, while a dead calm prevails at the surface of the earth; and when the day breeze is inadequate, then these evenly flowing night winds are sufficient. During several years I have not observed a continuous twenty-four hours when an upper current could not be reached, as evinced by the motion of tree branches. The kites rarely fly in precisely the same direction, owing to differences in the angle of inclination. The upper currents are revealed by a difference of direction, as compared with the direction manifested by the same kite at the ground. In the rare case that any two kites happen to fly exactly alike, they can still be maintained aloft by placing one kite a few feet farther away than the other, upward along the main line.

On the nights of June 2 and 3, 1893, a kite penetrated a cloud coming in from the sea and remained invisible some time. In August, 1892, the kite penetrated a shower cloud for a moment—it faded away and then came forth—but as the kite was of paper it was necessary to haul it down. The kite of June 2 and 3 was about 4 feet across, tailless, of paper, and rose to a height of about 1,200 feet. The clouds had probably begun to descend, but the surface was not foggy until toward midnight, the kite having been sent up about sundown. Water drops collected on the string near the kite while aloft, but at the ground the string was perfectly dry. This kite while in the air was soaked by mist which caused it to slowly descend.

The success of this tailless kite depends upon its surface being adjusted with extreme exactness. In case too much surface appears on one side the kite will fly sideways and work its way out of the line of the wind. This can be partly remedied by attaching small weights at one side of the kite; but if the surfaces adjoining the central spine are too much out of balance, even the adjustment of weights will not make the kite fly.

A further series of experiments with perforated malay kites will be carried out during 1894. So far I have experimented by cutting the outline of a small kite out of the center of a large one. This lessened the wind pressure during high winds and caused increased persistence

of movement. Extreme accuracy is called for, however, if a large opening in the kite is made, because a mistake of an inch will cause a side movement that will carry the kite downward. The late Mr. C. W. Hastings made an important suggestion regarding the management of kites in high winds—the kite to be proportionately and slightly weighted with sheet lead at its center of gravity, thus giving it inertia in high winds and resulting in stability. As before mentioned in this paper, I tried this method in the summer of 1892, when Mr. Hastings visited me at Bayonne, and found it successful. It remains to be elaborated in 1894. * * * In 1892 I read that some Chinamen flew kites at the base of Washington Monument, Washington, D. C., with the object, I suppose, of using the shaft to measure the altitude of their kites. Since the monument is 555 feet high, it would, of course admirably serve the purpose of a long unit of measurement. But the part of their pastime that interested me most was that they cut holes in their kites to make the movement steady. It seemed to me that if perforation produces steadiness, then the same principle might apply to flying-machine planes. I experimented with paper planes and found that a narrow-pointed plane, if given a convex under surface, might fall in equilibrium if launched with an impetus. But if a long narrow piece of paper were cut out of the center, as you might cut the bottom out of a boat, and along nearly its entire length, then the same plane, if weighted, will glide easily and swiftly through the air in the direction in which the first impulse is given. As about one-fifth of the plane is cut out from the center, it follows that there is a gain in lightness for flying purposes. A small model of this plane was mailed by me to Mr. Octave Chanute from New York City on June 5, 1893.

On pages 153–156 is the memoir presented to the International Conference by J. Woodbridge Davis, in which he relates the details of some experiments with kites which were apparently made in 1892–93 at various points on the coast of Rhode Island. His kites generally—

Consisted of a frame-work of three sticks of equal dimensions, pivoted at the center, free to turn on the pivot. They could, therefore, be folded for convenience of transportation. The general outline of the kite was that of a six-pointed star. The actual weight of a 7-foot kite, with cover and rigging, designed for a 40-mile wind is 6.25 pounds. This kite will safely bear a wind pressure of 250 pounds; the sticks are made of American ash. In order to steer the kite the three bridle lines attached to the three arms on the left side of the kite are brought to a single point where they are tied to a ring in such a manner as to be easily changed in length; the three bridle lines on the right-hand side are in the same way tied to another ring. To these two rings are separately fastened the two flying lines. These flying lines are manila cords, tested to bear 350 pounds each, and are paid off from two light wooden reels screwed to a platform pegged to the ground. By properly paying out these lines the kite is made to veer to the right or to the left through a deflection of 67.5° either way from the direction of the wind. As the tail always streamed out to leeward, therefore the kite was twisted around the vertical in proportion as the deflection increased. The next improvement was the attachment of a third or top line, by which the inclination of the plane of the kite to the horizon could be changed. When the top line was drawn in, the kite was made to mount to a point almost overhead. By using the top line and one flying line, the other being clamped, the kite was made to describe curves in the air; it was, for instance, lowered to a point 40° or 50° away from the leeward direction where an attendant pinned a message to the tail; the kite was then made to rise and travel to another place where it delivered the message. Again, it was made to drag a buoy and rope line through a strong cross tide, about five-eighths of a mile to a pier on Riker's Island. The top line steadied the kite on the same principle as the tail, besides supporting it until it could be made self-supporting; the flying lines steadied the kite laterally like guy lines, besides steering it, so that it could be accurately and steadily drawn in or let out through a space in the rigging of the vessel scarcely wider than itself. With one line the kite was unsteady in its movements; with two lines there was not the slightest tendency to lateral oscillation.

Finally, on pages 166–167 is the interesting paper of Prof. Mark W. Harrington, at that time Chief of the Weather Bureau. The following extracts are of historical interest, as bearing upon the use of kites:

The exploration of the upper air is the immediate requirement for the satisfactory advance of meteorology. There is abundant reason to think that many of the changes which go under the name of weather have their origin at some distance above the earth; and of what occurs in the cloud layer or layers, our knowledge is insignificant or theoretical. * * * The method of kites has been studied especially by Mr. William A. Eddy, of Bayonne, N. J., and the data which I give I owe entirely to his kindness. He uses tailless kites, places them in tandem, and recommends that they be flown in groups of three. By such means he has already attained heights of 4,000 to 5,000 feet, and confidently expects to attain 14,000 feet without serious difficulty. On my request that he estimate the cost of carrying meteorological instruments to this height, he gave me the following estimate, on the basis that the line would average an angle of 45° with the horizon, and would have to be about 23,000 feet in length. * * *

Mr. Eddy adds "that in lighter winds, perhaps 50 kites would be required, the above estimate applying for winds of about 10 miles per hour. All the kites are tailless, and fly at an angle of about 80° from the horizontal for the first 300 feet of line out. In case the pull becomes too great for the breaking strain the lower and larger tandem kites can be hauled in. The breaking strain of the cordage must be known and the pull at the earth's surface constantly measured to prevent the entire line from breaking away. This is a rough estimate, but is founded upon careful experiments during two years. The top kites and twine should be laid out the night or the day before, and the line should be extended along the ground for several thousand feet. Soon after daybreak the top kites should be started up, the top one lifting up the next, and so on. The kites will right themselves regardless of the position in which they are when lifted by the higher kites. Instruments should be suspended between two groups of three kites each.

Three tailless kites will fly when any one of the three will not, in very mild surface winds. For safety it would be well to have the kites in groups of threes."

Mr. Eddy is not ready to give a limit to which kites can be flown, but is not without hope that they can be made to reach the cirrus clouds. In winds of high velocity the kites must be perforated to relieve them from too strong air pressure. The tailless kites easily right themselves when reversed, and a tandem series of kites tends to prevent the jerking which might put the instruments out of order. * * *

The preceding (three) methods, while they would give highly interesting and instructive results, would be somewhat imperfect as a means of obtaining all the information needed by meteorologists. Much better for this purpose would be systematic work by a meteorologist who would make the ascension himself. Evidence points to the conclusion that the cloud layer, and perhaps the upper cloud surface, is a region of especial activity in meteorological phenomena, but the facts by which such a conclusion could be verified are of such a character that they would probably escape any automatic registry. Their record requires the presence of a trained meteorologist. These observations should be systematic, as the sporadic ones are of relatively little value. A meteorologist should ascend twice a day to a considerable height, and should keep this up through all kinds of weather, and through the season. The elevation need not be great, probably the first 20,000 feet include the layer of air in which the meteorological phenomena which we call weather are active. At least the stratum of this thickness is far more important to us than all the rest of the depth of the atmosphere.

The cost of such a campaign would be considerable, but would vary with the material used, the care in using it, the position of the station, etc. I think a year's campaign of this sort could be gone through for an expense of $20,000.

In conclusion, it appears that a year's campaign could be made in the free air at the following estimated cost:

To 3,000 feet (perhaps) with small balloons	$3,000
To 14,000 feet with kites	10,000
To 20,000 feet, 52 pilot balloons. } To 50,000 feet, 12 pilot balloons. }	3,000
To 20,000 feet with aeronaut	20,000

The results to be obtained would be cheap at any of these prices, but the fourth method seems to be incomparably the best as well as the most certain. A year's campaign of this sort would add very greatly—more than any other possible way in the same time—to the knowledge of meteorology, and hence to the forecasting of the weather. There is no other way, I believe, in which this sum of money could be expended to the greater advantage of meteorology.

After the reading of the above paper it was, upon the motion of Mr. D. Torrey, unanimously resolved:

That it is the sense of this meeting that the experiments proposed by Mr. Harrington are likely to prove of public value in forecasting the weather, and that Congress should, in our judgment, make the necessary appropriation to have the experiments made as recommended by Mr. Harrington.

In concluding this review of the state of our knowledge in 1893, the Editor would call attention to the fact that the malay kite and the free balloon were then looked upon as the means for occasionally obtaining isolated items of information from the upper regions; the world had not then awakened to the possibility of the work inaugurated by Professor Moore in July, 1895, which looks to the compilation of a daily map of simultaneous observations high above the earth's surface and

over a large portion of the United States, for study in connection with the map of surface conditions. Observations of the air at a single station can have but little value compared with the international balloon work of Europe or the extended national kite work of the Weather Bureau.

In his recent address at Toronto, before the British Association for the Advancement of Science, Professor Moore said:

For twenty-seven years the forecasters of the Weather Bureau have studied the inception, development, and progression of these different classes of atmospheric disturbances. From a knowledge personally gained by many years service as an official forecaster, I do not hesitate to express the opinion that we have long since reached the highest degree of accuracy in the making of forecasts possible to be attained with surface readings. It is patent that we are extremely ignorant of the mechanics of the storm; of the operations of those vast yet subtle forces in free air which give inception to the disturbance and which supply the energy necessary to continue the same. Long having realized this, I determined at once, on coming to the control of the United States Weather Bureau, to systematically attack the problem of upper-air exploration, with the hope ultimately of being able to construct a daily synoptic weather chart from simultaneous readings taken in free air at an altitude of not less than one mile above the earth. It appeared to me that all previous plans for investigating the upper air, by means of free and uncontrollable balloons, by observers in balloons, or by isolated kite stations or mountain observatories, were of little value in getting the information absolutely necessary to the improvement of our methods of forecasting. Simultaneous observations, at a uniform high level, from many cooperating kite stations, was the fundamental feature of the plan that I inaugurated for the prosecution of this important investigation.

Professor Marvin was assigned to the difficult task of devising appliances and making instruments, and I am pleased to say that we have improved on kite flying to such an extent that apparatus is now easily sent up to a height of one mile in only a moderate wind. We have made an automatic instrument that, while weighing less than two pounds, will record temperature, pressure, humidity, and wind velocity. By January next we expect to have not less than twenty stations placed between the Rocky Mountains and the Atlantic Ocean taking daily readings at an elevation of one mile or more.

We shall then construct a chart from the high-level readings obtained at these twenty stations and study the same in connection with the surface chart made at the same moment. As we shall thus be able to map out not only, as now, the horizontal gradients for the lower surface conditions, but in addition the simultaneous gradients for the upper level, and what is of still more importance, shall be able to deduce from these, for any section of the atmosphere, the simultaneous vertical gradients of temperature, humidity, pressure, and wind velocity, we may confidently hope to better understand the development of storms and cold waves, and eventually improve the forecasts of their future course, extent, and rate of movement. * * * It will be a fascinating study to note the progress of cold waves at the upper and lower levels, and to determine whether the changes in temperature do not first begin above. * * * I am anxious to know the difference in temperature between the surface and the upper stratum in the four quadrants of the cyclone, and also of the anti-cyclone, especially when the storm or cold-wave conditions are intense. * * * The vertical distribution of temperature in the several quadrants may give a clue to the future direction of movement of the disturbance.

METEOROLOGICAL TABLES.

By A. J. Henry, Chief of Division of Records and Meteorological Data.

Table I gives, for about 130 Weather Bureau stations making two observations daily and for about 20 others making only the 8 p. m. observation, the data ordinarily needed for climatological studies, viz, the monthly mean pressure, the monthly means and extremes of temperature, the average conditions as to moisture, cloudiness, movement of the wind, and the departures from normals in the case of pressure, temperature, and precipitation; the altitudes of the instruments, the total depth of snowfall, and the mean wet-bulb temperatures are now given.

Table II gives, for about 2,400 stations occupied by voluntary observers, the extreme maximum and minimum temperatures, the mean temperature deduced from the average of all the daily maxima and minima, or other readings, as indicated by the numeral following the name of the station; the total monthly precipitation, and the total depth in inches of any snow that may have fallen. When the spaces in the snow column are left blank it indicates that no snow has fallen, but when it is possible that there may have been snow of which no record has been made, that fact is indicated by leaders, thus (....).

Table III gives, for about 30 Canadian stations, the mean pressure, mean temperature, total precipitation, prevailing wind, total depth of snowfall, and the respective departures from normal values. Reports from Newfoundland and Bermuda are included in this table for convenience of tabulation.

Table IV gives detailed observations at Honolulu, Republic of Hawaii, by Curtis J. Lyons, meteorologist to the Government Survey.

Table V gives, for 26 stations, the mean hourly temperatures deduced from thermographs of the pattern described and figured in the Report of the Chief of the Weather Bureau, 1891–'92, p. 29.

Table VI gives, for 26 stations, the mean hourly pressures as automatically registered by Richard barographs, except for Washington, D. C., where Foreman's barograph is in use. Both instruments are described in the Report of the Chief of the Weather Bureau, 1891–'92, pp. 26 and 30.

Table VII gives, for about 130 stations, the arithmetical means of the hourly movements of the wind ending with the respective hours, as registered automatically by the Robinson anemometer, in conjunction with an electrical recording mechanism, described and illustrated in the Report of the Chief of the Weather Bureau, 1891–'92, p. 19.

Table VIII gives, for all stations that make observations at 8 a. m. and 8 p. m., the four component directions and the resultant directions based on these two observations only and without considering the velocity of the wind. The total movement for the whole month, as read from the dial of the Robinson anemometer, is given for each station in Table I. By adding the four components for the stations comprised in any geographical division one may obtain the average resultant direction for that division.

Table IX gives the total number of stations in each State from which meteorological reports of any kind have been received, and the number of such stations reporting thunderstorms (T) and auroras (A) on each day of the current month.

Table X gives, for 56 stations, the percentages of hourly sunshine as derived from the automatic records made by two essentially different types of instruments, designated, respectively, the thermometric recorder and the photographic recorder. The kind of instrument used at each station is indicated in the table by the letter T or P in the column following the name of the station.

Table XI gives a record of rains whose intensity at some period of the storm's continuance equaled or exceeded the following rates:

Duration, minutes..	5	10	15	20	25	30	35	40	45	50	60	80	100	120
Rates pr. hr. (ins.)..	3.00	1.80	1.40	1.20	1.08	1.00	0.94	0.90	0.86	0.84	0.75	0.60	0.54	0.50

In the northern part of the United States, especially in the colder months of the year, rains of the intensities shown in the above table seldom occur. In all cases where no storm of sufficient intensity to entitle it to a place in the full table has occurred, the greatest rainfall of any single storm has been given, also the greatest hourly fall during that storm.

Table XII gives the record of excessive precipitation at all stations from which reports are received.

NOTES EXPLANATORY OF THE CHARTS.

Chart I.—Tracks of centers of high pressure. The roman letters show number and order of centers of high areas. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the 8 a. m. and 8 p. m., seventy-fifth meridian time, observations. The queries (?) on the tracks show that the centers could not be satisfactorily located. Within each circle is given the highest barometric reading reported near the center. A blank indicates that no reports were available. A wavy line indicates the axis of a ridge of high pressure.

Chart II.—Tracks of centers of low pressure. The roman letters show number and order of centers of low areas. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the 8 a. m. and 8 p. m., seventy-fifth meridian time, observations. The queries (?) on the tracks show that the centers could not be satisfactorily located. Within each circle is given the lowest barometric reading reported near the center. A blank indicates that no reports were available. A wavy line indicates the axis of a trough or long oval area of low pressure.

Chart III.—Total precipitation. The scale of shades showing the depth of rainfall is given on the chart itself. For isolated stations the rainfall is given in inches and tenths, when appreciable; otherwise, a "trace" is indicated by a capital T, and no rain at all, by 0.0.

Chart IV.—Sea-level isobars, surface isotherms, and resultant winds. The wind directions on this Chart are the computed resultants of observations at 8 a. m. and 8 p, m., daily; the resultant duration is shown by figures attached to each arrow. The temperatures are the means of daily maxima and minima and are not reduced to sea level. The pressures are the means of 8 a. m. and 8 p. m. observations, daily, and correspond to Professor Hazen's system of reduction; the barometer is not reduced to standard gravity, but the necessary reduction for 30 inches of the mercurial barometer is shown by the marginal figures for each degree of latitude.

Chart V.—Hydrographs for seven principal rivers of the United States.

TABLE I.—*Climatological data for Weather Bureau Stations, July, 1897.*

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.												Precipitation, in inches.			Wind.									
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Mean actual, 8 a. m. and 8 p. m. ÷ 2.	Mean reduced.	Departure from normal.	Mean max. and min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity: Miles per hour.	Maximum velocity: Direction.	Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.
New England.							68.8	+ 0.6											5.97	+ 2.6											
Eastport	76	69	74	29.92	30.01	+ .09	59.0	− 1.4	81	18	66	48	*	52	29	56	54	89	2.78	− 1.1	13	6,479	s.	31	s.	14	5	10	16	7.0	
Portland, Me	103	81	89	29.85	29.95	+ .03	66.1	− 1.9	88	9	73	51	27	60	22	62	60	85	2.62	− 1.0	10	5,154	s.	40	se.	14	6	10	15	6.9	
Northfield	872	15	59	29.05	29.96	+ .02	69.7	+ 4.5	95	5	80	44	27	60	34	66	64	86	8.04	+ 4.9	15	4,658	s.	29	se.	6	2	18	11	6.9	
Boston	125	115	181	29.85	29.98	+ .04	71.6	− 0.2	94	5	79	55	27	64	28	66	64	81	4.22	+ 0.8	10	7,971	sw.	48	s.	14	7	8	16	6.5	
Nantucket	14	43	54	30.01	30.02	+ .01	68.7	+ 0.9	80	10	74	57	1	64	16	66	66	93	4.32	+ 1.9	13	7,508	sw.	35	s.	14	10	7	14	6.3	
Woods Hole	......	51	57	......	......	......	68.2	0.0	78	16	72	54	1	64	16				5.30	+ 2.2	12	9,695	s.	52	se.	14	14	9	8	4.6	
Vineyard Haven	......	20	....	......	......	......	72.6	+ 2.0	85	9	80	55	2	65	23	....	....	....	5.28	+ 2.3	10	......	sw.				13	11	7	....	
Block Island	27	39	48	29.97	30.00	+ .03	68.8	0.0	78	16	74	56	1	64	17	67	66	93	5.08	+ 1.9	12	10,568	sw.	42	e.	27	5	16	10	6.2	
Narragansett Pier	......	10	....	......	......	......	71.0	+ 0.8	84	10	77	55	1	65	23	....	....	....	5.44	+ 2.3	11	......	s.	....	......	....	13	5	13	....	
New Haven	107	118	140	29.86	29.97	.00	72.2	+ 0.9	88	10	79	57	27	65	21	67	65	83	16.63	+11.7	14	5,926	sw.	43	s.	14	12	6	13	6.0	
Mid. Atlan. States.							76.0	0.0											6.51	+ 2.0											
Albany	97	84	113	29.86	29.97	+ .04	74.7	+ 1.7	96	10	83	56	28	66	26	68	65	78	6.67	+ 2.7	16	4,553	s.	30	se.	21	7	15	9	5.9	
Binghamton	875	79	90	......	......	......	72.1	......	95	9	81	53	15	63	31	....	....	....	2.30	......	12	3,629	se.	27	sw.	11	3	19	9	6.3	
New York	314	298	326	29.65	29.98	.00	72.8	− 1.0	89	10	79	60	27	66	21	67	65	82	9.52	+ 5.3	19	7,676	s.	54	nw.	23	8	10	13	6.3	
Harrisburg	377	94	102	29.57	29.97	− .01	75.5	+ 2.6	93	6	84	59	29	67	25	68	63	70	3.68	− 0.6	11	4,680	w.	32	w.	11	8	12	11	5.9	
Philadelphia	117	168	184	29.85	29.97	− .02	76.4	+ 0.3	94	10	84	63	27	69	23	69	67	78	7.70	+ 3.5	17	6,264	s.	40	nw.	23	3	15	13	6.8	
Atlantic City	52	68	76	29.93	29.98	.00	72.5	+ 0.3	87	31	77	62	14	68	19	69	69	90	8.01	+ 4.6	16	6,416	sw.	34	sw.	14	8	17	6	5.4	
Baltimore	123	68	82	29.83	29.96	− .02	76.9	− 1.7	94	23	85	62	29	69	23	69	66	72	6.93	+ 2.2	14	3,551	w.	29	e.	17	6	15	10	5.6	
Washington	112	59	76	29.86	29.97	− .02	76.9	− 0.7	92	*	86	61	15	68	24	70	68	78	5.78	+ 1.2	16	4,042	s.	34	n.	7	13	9	9	5.0	
Cape Henry	......	5	34	......	......	......	78.3	+ 0.7	96	23	85	67	16	72	24	....	....	....	5.63	0.0	11	......	se.	....	......	....	9	11	11	....	
Lynchburg	685	83	88	29.27	29.99	− .01	76.6	− 1.9	94	3	86	61	31	67	29	69	66	73	6.75	+ 2.8	13	2,421	nw.	18	w.	12	9	12	10	5.4	
Norfolk	57	88	93	29.94	30.00	− .01	79.2	+ 0.1	92	3	87	68	28	72	20	72	70	78	4.42	− 1.5	14	5,033	se.	38	nw.	28	11	13	7	4.8	
S. Atlantic States.							80.2	− 0.4											6.95	+ 0.6											
Charlotte	773	67	76	29.20	29.99	− .04	78.5	− 1.4	98	3	88	61	14	69	25	70	67	74	5.08	− 0.5	15	3,263	se.	24	se.	19	5	11	15	6.8	
Hatteras	11	17	36	30.00	30.01	− .02	78.9	+ 1.0	89	1	83	69	8	74	11	74	72	81	8.98	+ 2.6	13	6,828	s.	45	se.	13	11	13	7	5.1	
Kittyhawk	9	12	30	29.98	29.99	− .02	77.0	− 1.6	92	23	83	63	25	71	26	74	72	86	9.06	+ 3.2	13	7,209	sw.	48	sw.	25	16	8	7	3.9	
Raleigh	375	93	101	29.62	30.00	− .04	78.8	+ 0.5	96	3	88	65	15	70	23	71	68	74	4.90	− 3.0	17	3,345	sw.	32	nw.	1	6	15	10	6.4	
Wilmington	78	82	88	29.93	30.01	− .02	80.1	0.0	97	1	88	68	15	73	20	73	71	78	4.50	− 2.7	12	4,700	s.	30	s.	25	8	11	12	5.8	
Charleston	48	60	72	30.00	30.05	+ .01	81.6	− 0.7	99	1	87	71	14	76	17	74	71	73	9.42	+ 1.8	16	6,285	sw.	34	nw.	1	6	23	2	4.9	
Columbia	......	5	....	......	......	......	81.0	− 0.3	102	3	91	62	15	71	28	....	....	....	9.66	+ 4.1	14	......	sw.	....	......	....	10	16	5	....	
Augusta	180	89	103	29.82	30.00	− .01	81.6	− 0.6	101	3	92	62	15	72	29	73	70	76	6.10	+ 0.8	12	3,592	s.	32	nw.	21	9	17	5	5.0	
Savannah	98	63	86	29.94	30.03	− .02	82.0	− 0.8	102	1	91	67	14	73	23	74	72	78	8.10	+ 2.3	12	4,755	sw.	36	s.	27	12	8	11	5.2	
Jacksonville	43	69	84	29.98	30.03	− .02	82.3	− 0.3	99	1	91	68	15	74	25	75	73	80	3.67	− 2.8	13	5,283	sw.	34	sw.	12	6	18	7	5.4	
Florida Peninsula.							81.6	− 1.3											5.37	− 0.8											
Jupiter	28	13	30	30.02	30.05	− .05	80.6	− 1.7	91	2	86	69	5	75	18	76	74	82	5.89	+ 1.2	14	5,478	s.	29	sw.	11	2	19	10	6.4	
Key West	22	42	50	30.04	30.06	.00	82.6	− 1.8	91	4	87	70	7	78	13	76	74	75	3.98	+ 0.1	16	5,424	e.	37	nw.	13	3	21	7	6.0	
Tampa	36	60	68	30.01	30.05	− .01	81.6	− 0.5	94	21	89	70	17	74	23	75	73	79	6.23	− 3.6	15	4,038	e.	26	se.	8	8	19	4	4.8	
East Gulf States.							82.3	+ 0.8											4.04	+ 1.9											
Atlanta	1,131	92	126	28.87	30.03	− .04	78.4	0.0	97	1	88	59	14	69	24	70	67	74	4.74	+ 0.3	12	5,479	nw.	28	ne.	16	7	12	12	6.3	
Pensacola	56	78	90	29.97	30.03	− .02	82.7	+ 1.0	94	31	89	69	14	77	19	75	72	72	2.19	− 4.5	10	6,023	sw.	26	sw.	1	8	19	4	5.5	
Mobile	57	88	96	29.98	30.04	.00	82.0	+ 0.3	96	31	90	65	14	74	24	75	73	78	7.75	+ 1.2	11	4,853	nw.	37	sw.	6	13	12	6	5.0	
Montgomery	221	100	107	29.77	30.00	− .04	83.0	+ 0.8	98	1	93	63	14	73	27	73	69	71	1.40	− 3.1	9	4,073	n.	32	sw.	20	13	15	3	4.0	
Vicksburg	254	65	73	29.73	29.99	− .06	82.4	+ 0.5	96	1	92	64	14	73	25	73	70	74	5.31	+ 0.8	8	4,392	sw.	36	nw.	18	15	14	2	3.8	
New Orleans	54	112	120	29.97	30.03	.00	83.6	+ 1.0	95	31	91	71	17	76	17	75	72	72	4.70	− 1.8	15	4,942	sw.	26	n.	11	7	16	8	5.5	
Port Eads	......	27	....	......	......	......	84.2	+ 1.9	93	6	90	74	*	78	15	....	....	....	2.22	− 6.1	4	......	sw.	....	......	....	5	22	4	....	
West Gulf States.							84.0	+ 1.1											1.12	− 1.9											
Shreveport	249	77	84	29.72	29.98	− .04	84.8	+ 1.1	101	26	96	66	14	74	29	73	69	65	1.45	− 2.1	5	4,170	s.	56	s.	17	16	9	6	3.6	
Fort Smith	481	63	72	29.45	29.94	− .04	83.0	+ 1.5	102	7	94	59	14	72	38	73	69	64	3.26	− 1.2	8	3,870	e.	26	ne.	5	23	4	4	2.9	
Little Rock	302	71	79	29.67	29.98	− .03	83.8	+ 2.4	100	6	94	63	14	74	27	72	68	64	1.03	− 3.0	6	4,909	s.	27	nw.	11	18	7	6	4.4	
Corpus Christi	20	42	50	29.97	29.99	− .03	82.6	− 0.2	96	14	88	72	14	77	24	77	76	83	0.00	− 1.3	0	9,278	se.	32	se.	17	30	1	0	1.5	
Galveston	42	85	96	29.99	30.03	.00	84.2	− 0.4	93	11	88	70	27	80	20	77	75	76	0.78	− 2.3	4	7,085	s.	36	n.	27	27	3	1	2.1	
Palestine	510	54	61	29.46	29.99	− .04	84.4	+ 1.8	102	26	95	67	29	73	32	73	68	64	1.01	− 1.6	3	4,553	s.	36	e.	29	16	14	1	3.7	
San Antonio	704	95	104	29.24	29.96	− .04	85.0	+ 1.5	103	26	96	68	13	74	32	71	65	59	0.28	− 1.9	1	6,296	se.	34	se.	3	19	10	2	3.4	
Ohio Val. & Tenn.							77.9	+ 0.6											5.30	+ 1.3											
Chattanooga	762	106	112	29.24	30.03	− .01	78.6	− 0.1	98	*	88	57	14	69	31	70	67	74	3.43	− 0.6	13	4,373	sw.	32	s.	16	8	15	8	5.4	
Knoxville	1,004	80	88	28.99	30.02	− .03	76.8	+ 0.2	96	4	86	56	14	67	26	70	67	78	3.83	− 0.5	13	3,646	sw.	34	nw.	24	9	13	9	5.5	
Memphis	399	140	154	29.57	29.98	− .04	82.1	+ 0.9	97	10	90	62	14	74	22	72	68	67	2.42	− 1.1	6	5,464	sw.	35	nw.	21	15	8	8	4.9	
Nashville	545	128	134	29.43	29.99	− .01	79.4	− 0.1	100	3	89	62	*	70	28	70	67	71	8.53	+ 4.2	16	4,036	nw.	34	ne.	8	11	15	5	4.5	
Lexington	989	75	122	28.94	29.96	− .05	75.7	0.0	95	4	85	54	13	66	24	69	66	75	4.34	− 0.4	14	6,542	sw.	40	s.	24	7	14	10	6.0	
Louisville	525	114	136	29.42	29.97	− .03	79.4	+ 0.6	100	3	90	58	13	69	30	70	66	68	5.21	+ 1.4	9	5,060	sw.	32	n.	10	11	12	8	5.1	
Indianapolis	823	154	164	29.10	29.94	− .07	77.0	+ 0.7	99	9	86	55	14	68	25	71	68	76	5.70	+ 1.4	16	5,984	nw.	33	n.	24	13	13	5	4.2	
Cincinnati	628	152	157	29.30	29.96	− .04	77.9	+ 0.4	98	4	87	57	13	69	24	69	65	70	6.71	+ 3.3	10	4,737	nw.	26	nw.	5	16	10	5	3.9	
Columbus	824	87	100	29.08	29.93	− .07	77.2	+ 1.2	102	4	87	55	13	67	29	70	67	76	6.95	+ 3.7	11	4,212	w.	27	nw.	12	12	14	5	4.8	
Pittsburg	842	116	126	29.10	29.97	− .02	76.2	+ 1.1	99	5	85	59	14	67	29	69	66	75	4.52	− 0.2	15	4,041	se.	28	s.	18	4	24	3	5.2	
Parkersburg	638	77	84	29.31	29.97	− .07	76.5	+ 1.2	99	4	86	58	14	67	29	69	66	76	6.68	+ 2.3	16	3,403	se.	20	nw.	12	6	18	7	5.9	
Lower Lake Region.							74.0	+ 2.2											4.48	+ 1.4											
Buffalo	768	178	206	29.12	29.92	− .03	74.0	+ 4.7	95	10	81	58	13	67	24	66	63	71	8.29	+ 5.1	14	8,553	sw.	45	sw.	11	4	16	11	6.5	
Oswego	335	76	87	29.56	29.92	− .04	71.9	+ 2.6	94	5	79	55	27	65	22	66	64	79	3.15	0.0	13	5,936	se.	25	se.	27	11	9	11	5.3	
Rochester	523	81	90	29.37	29.92	− .03	74.0	+ 2.5	99	*	83	50	15	65	26	66	63	74	6.37	+ 3.4	15	4,501	sw.	27	sw.	22	12	10	9	5.3	
Erie	714	92	102	29.19	29.93	− .04	73.0	+ 1.2	94	10	80	59	14	66	22	67	64	73	5.81	+ 3.0	15	6,917	s.	29	w.	30	11	8	12	5.4	
Cleveland	762	190	201	29.13	29.92	− .07	73.8	+ 2.3	97	4	81	56	14	67	24	67	63	71	2.48	− 1.0	13	7,984	s.	39	w.	5	10	14	7	4.8	
Sandusky	629	62	74	29.27	29.92	− .07	75.6	+ 1.1	100	4	84	56	13	67	26	68	64	71	4.29	+ 1.2	11	5,137	sw.	26	nw.	21	8	11	12	5.6	
Toledo	674	122	127	29.23	29.92	− .06	75.2	+ 0.5	98	4	84	56	13	66	26	68	65	73	3.73	+ 0.8	13	5,727	w.	45	s.	16	12	16	3	4.4	
Detroit	730	160	166	29.16	29.92	− .06	74.8	+ 2.8	94	4	83	57	14	67	21	67	63	68	1.70	− 1.7	10	5,584	ne.	28	w.	22	18	8	5	3.8	
Upper Lake Region.							70.8	+ 3.0											3.23	+ 0.8											
Alpena	609	61	65	29.27	29.91	− .04	69.0	+ 3.7	98	4	77	52	14	61	24	64	61	77	3.81	+ 0.9	11	5,709	se.	25	se.	3	12	14	5	4.9	
Grand Haven	628	55	64	29.26	29.92	− .05	72.4	+ 2.7	93	9	81	50	14	63	36	66	63	73	3.03	+ 0.3	7	5,755	nw.	28	w.	5	16	11	4	3.5	
Marquette	734	67	95	29.11	29.87	− .08	69.2	+ 3.2	97	3	77	52	12	61	27	64	60	77	3.04	0.0	13	5,582	n.	40	sw.	30	8	14	9	5.5	
Port Huron	639	70	108	29.27	29.94	− .02	72.4	+ 2.6	96	10	81	55	14	64	28	66	63	76	3.51	+ 1.1	15	6,081	n.	37	e.	18	17	10	4	3.8	
Sault Ste. Marie	624	58	65	29.25	29.90	− .06	67.6	+ 5.5	92	8	78	47	1	57	36	62	60	79	4.03	+ 1.0	9	5,239	nw.	28	sw.	30	14	13	4	4.5	
Chicago	824	241	274	29.08	29.93	− .05	74.2	+ 1.9	95	3	80	56	13	68	24	68	64	73	1.47	− 2.0	9	9,963	n.	72	w.	5	12	16	3	4.1	
Milwaukee	671	106	149	29.23	29.93	− .05	73.2	+ 3.8	98	3	81	55	13	66	30	66	63	72	2.33	− 0.8	10	5,813	e.	29	s.	5	14	8	9	4.7	
Greenbay	617	49	57	29.28	29.93	− .05	73.2	+ 3.5	95	8	83	51	13	64	28	66	63	73	3.92	+ 1.0	8	4,892	s.	36	w.	9	18	10	3	3.8	
Duluth	702	95	106	29.14	29.87	− .05	66.4	− 0.3	87	30	74	52	16	58	29	61	58	80	9.29	+ 5.6	15	5,890	ne.	48	nw.	2	9	16	6	5.1	
North Dakota.							70.1	+ 0.6											3.64	+ 0.8											
Moorhead	935	54	60	28.86	29.83	− .08	70.7	+ 2.9	90	2	80	52	13	61	32	66	64	81	8.02	+ 4.1	15	6,676	se.	35	se.	17	10	14	7	4.8	
Bismarck	1,674	16	29	28.12	29.84	− .06	70.4	0.0	99	28	82	55	14	58	37	61	55	65	1.53	− 0.9	10	6,318	se.	35	sw.	3	12	17	2	4.4	
Williston	1,875	15	31	27.91	29.83	− .05	69.2	− 1.0	98	28	83	46	26	55	40	57	48	53	1.36	− 0.8	5	5,853	n.	36	nw.	17	22	8	1	3.1	
Upper Miss. Valley.							76.9	+ 1.4											4.32	+ 0.7											
Minneapolis	......	99	....	......	......	......	74.4	+ 2.6	95	8	84	55	12	65	28	....	....	....	4.27	+ 0.4	12	......	s.	....	......	....	8	15	8	....	
St. Paul	837	114	124	29.00	29.87	− .08	73.8	+ 1.8	94	8	83	55	12	65	26	66	63	71	6.35	+ 3.0	13	5,494	s.	36	se.	7	8	15	8	5.3	
La Crosse	......	70	78	......	......	......	74.6	+ 1.3	95	8	84	53	13	65	26	....	....	....	1.50	− 2.6	10	4,577	s.	34	nw.	4	14	8	9	4.9	
Davenport	597	71	79	29.28	29.91	− .08	77.4	+ 2.2	99	9	87	54	13	68	26	68	64	66	3.21	− 0.4	6	4,931	e.	26	w.	21	14	9	8	4.6	
Des Moines	867	84	88	29.03	29.93	− .08	76.4	+ 1.4	98	31	87	52	13	66	28	68	64	69	2.88	− 0.6	10	5,653	se.	50	nw.	23	20	8	3	3.1	
Dubuque	698	49	56	29.19	29.91	− .06	76.0	+ 1.7	98	9	86	55	13	66	29	67	62	68	4.34	+ 0.1	9	4,405	nw.	28	nw.	9	22	5	4	3.1	
Keokuk	614	64	78	29.30	29.93	− .05	78.3	+ 1.1	97	9	88	55	13	69	26	71	67	71	6.75	+ 2.6	10	4,579	sw.	37	w.	23	17	11	3	3.4	
Cairo	359	87	93	29.50	29.96	− .03	80.0	+ 1.0	98	31	88	60	14	72	27	73	70	75	2.76	− 0.7	6	4,425	s.	29	se.	9	11	12	8	4.8	

TABLE I.—*Climatological data for Weather Bureau Stations, July, 1897*—Continued.

Stations.	Elevation of instruments			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.												Precipitation, in inches.			Wind.									
	Barometer above sea level, feet.	Thermometers above ground.	Anemometers above ground.	Mean actual, 8 a. m. and 8 p. m. ÷ 2.	Mean reduced.	Departure from normal.	Mean max. and min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.
Up. Miss. Val.—Con																															
Springfield, Ill.	644	82	92	29.28	29.94	− .06	77.5	+ 0.3	98	9	87	55	13	68	24	70	66	71	4.16	+ 1.4	9	5,631	s.	30	nw.	10	12	14	5	4.4	
Hannibal	534	75	107	....	....	....	78.0	....	97	9	87	56	13	69	26	....	....	....	8.04	+ 4.9	10	5,393	sw.	36	sw.	20	22	6	3	2.8	
St. Louis	567	111	210	29.37	29.96	− .03	80.6	+ 1.1	97	*	89	62	13	72	22	72	68	69	3.23	− 0.5	9	6,141	s.	28	n.	24	17	9	5	4.0	
Missouri Valley.							77.5	+ 1.5											3.20	− 0.8											
Columbia	......	4	84	......	......	......	78.8	+ 2.6	100	31	90	51	13	67	31	....	....	....	4.28	− 0.6	8	4,790	se.	28	w.	20	17	10	3	3.7	
Kansas City	963	78	95	28.95	29.93	− .04	80.4	+ 1.9	102	30	90	60	13	71	29	70	66	66	4.29	+ 0.1	7	5,668	s.	24	s.	3	18	8	5	3.3	
Springfield, Mo.	1,324	100	103	28.60	29.95	− .03	78.2	+ 0.2	95	*	87	56	13	69	23	70	66	69	2.48	− 2.3	6	6,278	s.	36	nw.	10	18	12	1	3.0	
Topeka	......	81	....	......	......	......	80.4	+ 3.4	102	31	92	57	13	69	34	....	....	....	3.89	− 1.3	5	....	se.	....	......	...	19	9	3	....	
Lincoln	1,199	74	84	28.65	29.87	....	78.2	+ 1.4	100	31	90	53	13	66	34	69	64	65	2.54	− 0.8	6	7,916	se.	42	s.	3	15	6	0	3.8	
Omaha	1,103	92	97	28.75	29.88	− .09	78.8	+ 1.7	102	31	89	57	12	68	29	68	64	65	2.01	− 2.7	9	5,761	se.	43	sw.	9	16	14	1	3.4	
Sioux City	1,139	96	169	....	....	....	76.2	+ 1.6	102	31	88	50	13	64	32	....	....	....	2.26	− 1.0	6	9,538	s.	57	w.	2	17	10	4	3.4	
Pierre	1,460	50	61	28.33	29.83	− .08	75.6	+ 0.5	99	13	88	53	5	63	36	64	59	63	3.79	+ 1.6	6	6,473	se.	44	w.	4	14	12	5	4.3	
Huron	1,306	63	72	28.50	29.86	− .08	73.2	+ 1.0	100	7	86	47	12	60	42	64	60	69	2.32	− 0.8	10	8,951	se.	45	se.	7	17	8	6	4.4	
Yankton	1,234	51	57	28.60	29.86	− .07	75.4	+ 1.0	100	31	88	53	12	63	36	66	62	67	4.14	+ 0.3	10	6,279	s.	41	s.	2	21	8	2	2.7	
Northern Slope.							68.1	− 1.9											1.54	− 0.1											
Havre	2,494	15	33	27.28	29.82	− .06	65.7	− 2.2	96	12	79	46	27	52	45	54	45	54	0.78	− 1.4	6	7,235	w.	48	se.	30	18	11	2	3.6	
Miles City	2,372	41	49	27.40	29.81	− .08	72.5	− 1.2	100	28	87	45	4	58	41	57	45	46	0.59	− 0.8	8	5,171	nw.	51	w.	22	17	11	3	3.3	
Helena	4,108	88	93	25.86	29.96	+ .05	63.6	− 2.9	95	27	75	42	9	52	42	51	41	51	1.89	+ 0.8	11	5,909	sw.	48	sw.	12	14	8	9	4.4	
Rapid City	3,251	53	61	26.60	29.84	− .07	71.0	+ 0.3	99	28	84	50	10	58	39	57	46	46	0.71	− 1.0	7	5,961	w.	38	sw.	17	13	9	9	4.7	
Cheyenne	6,105	58	60	24.10	29.89	.00	65.0	− 3.4	92	29	80	40	*	50	44	51	38	45	3.77	+ 2.0	11	6,534	nw.	35	nw.	2	15	12	4	4.4	
Lander	5,372	28	36	24.70	29.93	+ .01	65.1	− 4.3	91	28	81	41	18	49	42	51	37	44	1.21	+ 0.4	6	4,153	sw.	37	sw.	22	13	13	5	4.7	
North Platte	2,826	43	52	27.05	29.88	− .05	74.5	+ 0.5	103	29	88	51	4	61	42	63	58	62	1.85	− 0.9	10	6,583	nw.	48	nw.	8	14	15	2	4.2	
Middle Slope.							77.2	+ 0.2											2.69	− 0.1											
Denver	5,290	83	151	24.81	29.92	+ .05	69.8	− 3.0	96	7	84	43	20	56	39	54	42	46	2.06	+ 0.4	9	5,674	s.	48	w.	27	9	15	7	5.0	
Pueblo	4,713	74	81	25.32	29.90	+ .01	73.0	− 1.5	101	13	89	43	20	57	45	55	40	41	1.45	− 0.7	8	5,326	nw.	36	nw.	1	15	13	3	4.0	
Concordia	1,398	42	47	28.45	29.88	− .07	79.7	+ 2.6	102	31	92	56	13	67	34	68	63	61	5.31	+ 2.2	6	5,271	s.	30	s.	2	16	11	4	3.8	
Dodge City	2,504	44	52	27.37	29.88	− .03	78.8	+ 0.3	100	29	92	53	11	65	35	65	58	56	3.91	+ 0.8	6	9,091	s.	41	s.	2	21	8	2	2.7	
Wichita	1,351	78	85	28.53	29.91	− .03	81.2	+ 1.7	102	30	94	55	13	69	33	68	63	61	1.49	− 1.6	9	6,112	s.	32	n.	27	21	7	3	2.6	
Oklahoma	1,218	54	53	28.70	29.94	− .01	80.8	+ 1.1	103	14	91	57	12	70	37	70	65	63	1.90	− 1.9	3	7,519	s.	40	sw.	20	25	6	0	1.7	
Southern Slope.							80.2	+ 0.4											2.08	+ 0.2											
Abilene	1,749	47	54	28.18	29.93	− .03	83.9	+ 0.5	105	26	96	61	12	72	31	69	61	53	2.00	+ 0.3	5	6,724	se.	40	ne.	17	19	12	0	2.7	
Amarillo	3,691	53	61	26.30	29.94	− .01	76.4	+ 0.4	97	14	88	55	20	65	31	63	55	57	2.16	0.0	9	11,098	s.	52	w.	20	16	10	5	3.7	
Southern Plateau.							81.9	− 1.6											1.58	+ 0.1											
El Paso	3,767	10	110	26.21	29.90	+ .03	80.0	− 3.7	99	14	91	57	14	69	42	63	53	49	2.89	+ 0.8	7	7,282	ne.	60	sw.	23	13	16	2	4.0	
Santa Fe	6,998	47	50	23.40	29.96	+ .02	67.0	− 2.2	85	8	78	43	20	56	34	53	42	48	2.85	+ 0.1	14	4,333	se.	33	ne.	3	13	18	0	4.4	
Phœnix	1,076	47	57	28.68	29.76	.....	89.6	+ 0.1	107	30	108	67	25	76	38	67	53	34	0.59	− 0.3	3	3,669	e.	26	se.	18	21	10	0	2.1	
Yuma	139	16	50	29.62	29.76	− .04	91.1	− 0.4	112	10	105	69	2	77	39	70	59	41	T.	− 0.1	0	5,071	sw.	35	se.	11	24	7	0	1.6	
Middle Plateau.							68.9	− 2.4											0.36	+ 0.1											
Carson City	4,720	82	92	25.30	29.93	....	66.8	− 0.9	91	12	82	39	8	52	43	50	33	34	0.31	+ 0.1	3	5,126	w.	32	w.	1	28	3	0	1.1	
Winnemucca	4,340	59	70	25.69	29.93	+ .08	68.1	− 2.8	96	12	84	35	8	52	43	51	29	30	0.08	− 0.1	1	6,269	sw.	36	w.	12	23	4	4	2.9	
Salt Lake City	4,344	83	90	25.66	29.92	+ .05	71.9	− 3.6	98	28	85	49	4	59	37	58	46	44	0.69	+ 0.2	5	4,687	se.	32	s.	7	16	10	5	3.8	
Northern Plateau.							66.0	− 3.6											0.56	0.0											
Baker City	3,470	49	47	26.48	29.99	+ .05	62.2	− 4.4	93	11	76	37	7	48	41	49	37	48	0.24	− 0.4	2	4,376	s.	20	n.	16	16	10	5	3.3	
Idaho Falls	4,742	10	56	25.27	29.93	+ .04	66.0	− 1.6	96	12	83	34	19	49	50	51	36	43	0.20	− 0.2	4	8,894	s.	50	sw.	17	16	9	6	3.7	
Spokane	1,943	99	107	27.95	29.95	+ .03	65.2	− 3.8	96	11	77	46	7	53	38	53	43	51	0.98	+ 0.3	9	5,200	sw.	27	nw.	16	13	9	9	4.5	
Walla Walla	1,018	65	73	28.92	29.98	+ .04	70.6	− 4.6	105	11	84	50	7	58	43	56	45	45	0.84	+ 0.5	4	5,048	s.	25	sw.	1	21	8	2	3.1	
N. Pac. Coast Reg.							59.6	− 1.6											1.23	+ 0.3											
Fort Canby	179	10	34	29.92	30.11	+ .05	57.8	− 0.8	69	13	62	49	*	53	15	55	53	88	1.21	+ 0.1	14	7,076	n.	57	s.	1	9	8	14	6.2	
Port Angeles	29	47	61	......	....	......	55.1	− 1.5	67	9	61	44	26	49	20	...	....	....	0.88	+ 0.5	8	5,904	w.	34	w.	2	12	11	8	4.6	
Pysht *h*	......	5	....	......	....	......	59.2	....	79	10	68	43	*	50	30	...	....	....	0.90	+ 0.1	6	....	w.	....	......	...	8	4	11	....	
Seattle	119	100	108	29.95	30.08	....	62.6	....	85	10	72	50	18	54	30	55	50	68	2.36	......	9	3,691	s.	28	sw.	1	14	10	7	4.1	
Tacoma	213	....	....	......	....	......	61.4	....	87	10	70	47	25	52	32	...	....	....	0.87	......	7	4,797	sw.	22	sw.	1	14	9	8	4.1	
Tatoosh Island	86	12	21	30.03	30.13	+ .06	55.0	− 1.2	62	13	59	48	25	51	11	54	52	88	3.11	+ 1.0	12	6,021	s.	32	s.	1	6	5	20	7.2	
Astoria	......	39	60	......	....	......	60.0	− 1.5	74	10	66	47	29	54	20	...	....	....	1.66	+ 0.6	9	....	nw.	....	......	...	13	7	11	....	
Portland, Oreg.	153	203	213	29.92	30.08	+ .05	64.6	− 3.2	92	10	74	50	*	55	31	56	50	66	0.65	+ 0.1	6	5,947	nw.	30	sw.	1	17	9	5	3.4	
Roseburg	521	56	67	29.49	30.05	+ .01	65.4	− 1.1	89	10	78	45	8	53	39	56	49	62	0.23	− 0.2	5	3,881	nw.	20	ne.	17	19	10	2	2.6	
Mid. Pac. C'st Reg.							65.2	+ 0.6											0.01	− 0.1											
Eureka	64	60	69	30.02	30.08	+ .02	55.8	0.0	67	18	61	46	20	51	21	53	51	86	0.03	− 0.1	2	6,065	nw.	44	nw.	17	15	13	3	3.9	
Redbluff	334	54	58	29.53	29.87	+ .01	82.1	+ 1.6	106	13	97	59	*	68	37	59	39	25	0.00	0.0	0	5,000	nw.	35	n.	17	29	2	0	0.4	
Sacramento	71	106	117	....	....	....	75.6	+ 2.4	105	11	92	52	23	60	41	....	....	....	0.00	0.0	0	6,588	sw.	29	n.	3	30	1	0	0.5	
San Francisco	153	161	167	29.79	29.95	− .01	58.2	− 1.8	82	12	65	47	10	51	29	53	51	84	T.	0.0	0	10,634	w.	39	w.	1	19	12	0	3.0	
Point Reyes Light	......	12	....	....	....	....	54.4	+ 0.9	80	12	61	45	10	48	30	....	....	....	0.00	− 0.3	0	....	nw.	....	......	...	18	2	11	....	
S. Pac. Coast Reg.							73.1	− 0.6											T.	0.0											
Fresno	332	67	70	29.48	29.82	− .04	82.8	+ 0.6	110	11	100	52	27	65	52	60	43	31	0.00	0.0	0	4,886	nw.	21	nw.	1	27	4	0	0.9	
Los Angeles	330	74	76	29.58	29.93	− .01	69.5	− 1.3	86	15	80	52	8	59	28	62	59	78	T.	0.0	0	3,271	w.	15	w.	23	6	25	0	3.5	
San Diego	69	59	70	29.84	29.94	− .01	67.0	− 1.0	79	14	71	59	3	63	15	62	59	79	0.01	0.0	1	4,347	nw.	18	nw.	30	29	1	1	1.9	
San Luis Obispo	201	10	46	29.76	29.98	....	65.5	....	89	13	80	44	7	51	38	56	51	69	0.00	....	0	2,980	w.	13	w.	6	24	7	0	2.7	

NOTE.—The data at stations having no departures are not used in computing the district averages. Letters of the alphabet denote number of days missing from the record. * Two or more dates. † Received too late to be considered in departures, etc.

TABLE II.—*Meteorological record of voluntary and other cooperating observers, July, 1897.*

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
	°	°	°	*Ins.*	*Ins.*
Alabama.					
Alco †	100	57	81.7	6.28	
Ashville †	104	54	81.3	5.17	
Bermuda †	98	58	81.2	4.30	
Birmingham	99	59	82.0	6.16	
Brewton †	98	66	81.6	7.35	
Bridgeport †	......	......	......	3.04	
Citronelle †	95	66	82.5	9.07	
Clanton †	95	58	80.8	0.56	
Daphne †	98	61	82.8	3.38	
Decatur †	105	54	79.7	3.67	
Demopolis	......	......	......	5.73	
Elba †[4]	95	57	80.6	......	
Eufaula *a* †	101	56	81.9	3.73	
Evergreen †	96	65	82.0	5.38	
Florence *a* †	......	......	......	3.91	
Florence *b* †	103	56	81.4	3.18	
Fort Deposit †	101	61	83.9	1.47	
Gadsden	103	55	82.8	3.64	
Goodwater †	102	58	81.5	4.16	
Greensboro †	98	60	81.2	6.61	
Hamilton	100	52	80.0	2.94	
Healing Springs †	99	57	80.4	9.04	
Highland Home †	97	65	82.2	2.81	
Lock No. 4	101	57	80.7	4.51	
Madison Station †	103	54	77.7	7.05	
Maple Grove	103	50	76.0	3.77	
Marion †	99	64	82.7	3.25	
Mount Willing †	100	52	82.2	0.83	
Newbern †	97	65	82.3	4.38	
Newburg	103[4]	50[4]	81.6[4]	3.55	
Newton †	100	59	80.8	10.49	
Opelika †	100	58	82.5	6.33	
Oxanna †	98	55	77.7	7.16	
Pineapple	101	57	82.5	3.48	
Pushmataha †	101	60	82.4	4.06	
Riverton †	......	......	......	2.18	
Rockmills †	96	55	77.8	6.57	
Scottsboro †	105	54	79.8	3.81	
Selma †	102	62	82.7	5.52	
Talladega *[1]	95	60	79.4	3.79	
Tallassee	......	......	......	4.53	
Tuscaloosa †	102	64	82.6	6.81	
Tuscumbia	103	58	82.1	3.36	
Union †	104	56	81.9	7.00	
Union Springs †	98	61	83.0	5.19	
Uniontown †	97	64	83.3	2.60	
Valleyhead	98	53	76.8	3.61	
Warrior	......	......	......	6.21	
Wetumpka	100	59	83.4	2.04	
Wilsonville †	......	......	......	3.14	
Alaska.					
Killisnoo	66	42	52.2	5.30	
Arizona.					
Antelope Valley	......	......	......	1.47	
Bisbee †	92	57	75.4	7.36	
Buckeye †	108	64	87.0	0.03	
Calabasas	98	55	79.4	2.61	
Casa Grande *[8]	115	75	93.8	0.00	
Cedar Springs	......	......	......	1.64	
Congress	102	55	88.3	1.29	
Dragoon	......	......	......	2.51	
Dragoon Summit *[5]	99	70	83.3	1.23	
Dudleyville	103	60	82.0	1.03	
Farleys Camp †	109	68	89.5	0.70	
Flagstaff †	88	54	72.0	0.05	
Fort Apache	97	49	74.0	1.20	
Fort Defiance	90	38	66.8	1.42	
Fort Grant †	95	59	77.0	2.05	
Fort Huachuca †	94	57	75.4	3.05	
Gilabend *a* *[8]	109	81	97.0	0.20	
Gisela [1]	108	41	82.3	T.	
Glendale	107	63	87.8	0.22	
Holbrook †	96	44	73.3	0.77	
Lochiel *[1]	90[c]	63[c]	74.5[c]	4.57	
Maricopa *[8]	114	78	93.9	0.50	
Mesa †	110	68	90.4	0.33	
Mount Huachuca	93	58	75.4	4.32	
Music Mountain	110	55	86.6	0.03	
Natural Bridge	......	......	......	0.44	
Oracle †	98	63	80.7	0.55	
Oro	......	......	......	2.07	
Oro Blanco	100	61	80.6	1.90	
Pantano *[8]	100	67	82.0	2.99	
Payson	......	......	......	1.77	
Peoria †	107	69	89.8	0.49	
Phœnix	106	62	86.8	0.44	
Pinal Ranch	......	......	......	0.62	
Reymert †[c]	112	67	91.4	0.01	
St. Helena Ranch	......	......	......	3.39	
San Carlos †	109	62	85.4	0.66	
San Simon *[8]	102	65	78.8	......	
Showlow	......	......	......	0.57	
Signal †	112	65	90.6	0.22	
Snowflake	92	42	71.8	2.68	
Sulphur Spring Valley	......	......	......	1.77	
Texas Hill *[8]	118	83	95.3	0.30	
Arizona—Cont'd.					
Tombstone	95	62	77.8	3.24	
Tuba	103	43	75.4	0.19	
Tucson *c* †	103	65	87.2	1.98	
Walnut Grove	......	......	......	1.04	
Walnut Ranch *†[1]	93	57	72.8	4.49	
Whipple Barracks †	97	46	72.2	2.48	
Willcox *[8]	97	70	81.7	1.55	
Williams	92	40	68.0	1.50	
Arkansas.					
Amity	100	56	83.1	2.08	
Arkansas City †	......	......	......	3.50	
Beebranch †	99[1]	55[1]	78.8[1]	6.60[1]	
Blackton	......	......	......	3.67	
Blanchard Springs †	99	57	82.6	3.58	
Brinkley	102	56	81.8	2.96	
Camden *a* †	......	......	......	3.36	
Camden *b* †	102	54	82.0	3.30	
Canton *[1]	104	55	81.5	......	
Conway	107	59	84.6	5.18	
Corning †	102	54	81.0	1.48	
Dallas	102	56	83.3	3.04	
Dardanelle	......	......	......	2.47	
Elon †	102	55	82.2	3.85	
Fayetteville †	99	52	79.8	5.10	
Forrest	101	58	82.3	1.56	
Fulton †	......	......	......	1.40	
Helena *a* †	......	......	......	2.78	
Helena *b*	102	57	83.3	2.35	
Hot Springs *a*	104	58	84.4	4.70	
Hot Springs *b*	......	......	......	4.74	
Hot Springs (near)	......	......	......	7.62	
Jonesboro	106	51	78.8	5.20	
Keesees Ferry †	109	50	82.8	1.94	
Lacrosse †	103	54	80.6	2.40	
Lonoke *[1]	105	57	81.9	5.62	
Luna Landing *[6]	97	62	82.6	3.95	
Lutherville *[1]	107	64	84.8	......	
Magnolia	102	63	83.6	5.97	
Malvern †	107	54	84.0	2.63	
Marianna *[1]	102	65	84.7	......	
Marvell	103	61	83.4	4.44	
Moore	......	......	......	8.19	
Mossville	98	60	79.0	7.90	
Mount Nebo †	93	60	79.7	3.55	
New Gascony *[1]	98	68	84.4	2.29	
Newport *a* †	......	......	......	2.40	
Newport *b* †	102	55	80.8	2.41	
Newport *c* †	102	54	81.9	1.86	
Oregon *[1]	100	52	77.2	......	
Osceola †	98	61	81.6	1.91	
Ozark †	104	62	84.7	1.54	
Paragould	97	69	84.4	2.10	
Picayune †	101	58	84.2	2.02	
Pinebluff †	104	58	85.0	3.35	
Pocahontas †	98[c]	54[b]	79.4[b]	2.20	
Powell *†[1]	104	56	81.8	2.37	
Prescott	106	58	86.3	1.49	
Rison	104	57	84.4	1.00	
Russellville	103	56	83.9	1.47	
Silver Springs †	97	50	76.6	4.30	
Stuttgart †	101	56	82.9	4.32	
Texarkana †	106	58	86.2	1.05	
Warren †	104	57	84.4	1.22	
Washington *†[1]	103	62	85.4	0.65	
Wiggs *[1]	102	59	84.6	3.85	
Winslow	93	55	77.4	4.46	
Witts Springs †	98	52	78.9	3.80	
California.					
Arlington Heights	102	50	75.3	0.01	
Athlone *[8]	111	67	86.4	0.00	
Azusa	......	......	......	0.00	
Ballast Point L. H	......	......	......	0.00	
Barstow †	106	75	90.8	T.	
Berkeley	84	51	63.3	0.00	
Bishop †	98	42	70.6	0.01	
Boca *[6]	94	34	59.3	0.00	
Bodie †	83	21	55.4	0.53	
Bowmans Dam *†[1]	90	42	67.9	0.00	
Caliente *[8]	104	65	84.7	0.00	
Calloway Canal *†[8]	112	65	89.2	0.00	
Campbell	97	43	66.3	0.00	
Cape Mendocino L. H	......	......	......	0.30	
Castle Pinckney *[1]	82	57	65.0	0.00	
Cedarville †	92	39	66.1	0.51	
Centerville *[1]	100	58	60.8	0.00	
Chico *[8]	108	65	85.1	0.00	
Cisco *[8]	82	40	60.0	0.00	
Claremont †	96	47	72.2	0.00	
Corning *[8]	105	68	84.1	0.00	
Craftonville	106	50	78.4	T.	
Crescent City †	87	39	55.9	0.15	
Crescent City L. H	......	......	......	0.00	
Daunt	......	......	......	0.25	
Davisville (*b*)	104	50	76.8	0.00	
Delano *[8]	105	65	85.0	0.00	
Delta *[8]	104	60	78.4	0.00	
California—Cont'd.					
Descanso *[5]	92	38	67.0	0.62	
Drytown	112	45	76.8	0.00	
Dunnigan *[8]	106	64	82.2	0.00	
Durham *[1]	101	53	76.6	0.00	
East Brother L. H	......	......	......	0.00	
Edmanton *[1]	89	42	62.6	0.00	
Elsinore	108	53	79.6	0.00	
Escondido	101	47	73.4	......	
Fallbrook *[1]	96	54	69.4	0.01	
Folsom City *b* *[1]	107	62	81.0	0.00	
Fordyce Dam	......	......	......	0.00	
Fort Bragg †	......	......	......	0.01	
Fort Ross	75	45	57.8	0.00	
Georgetown	96	49	73.2	0.00	
Goshen *[8]	109	60	84.7	0.00	
Grand Island *[5]	106	54	79.8	0.00	
Grass Valley	......	......	......	T.	
Greenville †	94	31	63.2	T.	
Healdsburg *[1]	87	48	72.4	0.00	
Hollister	96	40	65.3	0.00	
Humboldt L. H	......	......	......	0.00	
Hydesville	77	40	57.8	0.00	
Indio *[8]	115	75	93.7	0.00	
Jackson	98	42	73.6	0.00	
Jolon	......	......	......	0.00	
Keeler *[8]	110	70	85.2	0.00	
Keene *[8]	101	60	78.7	0.00	
Kennedy Gold Mine	105	47	77.8	0.00	
Kernville	......	......	......	0.00	
King City *[8]	105	50	68.9	0.00	
Kingsburg *[8]	107	65	85.7	0.00	
Kono Tayee	95	54	75.2	0.00	
Lagrange *[8]	110	55	83.6	0.00	
Laporte *†[1]	86	43	60.8	0.00	
Lemoore *a* *[8]	109	59	84.4	0.00	
Lick Observatory	89	55	70.8	0.00	
Lime Kiln	111	52	83.0	......	
Lime Point L. H	......	......	......	0.00	
Lodi	103	50	75.8	0.00	
Los Gatos *b*	98	44	68.2	0.00	
Lytton Springs	102	50	72.5	T.	
McMullin *[1]	106	52	85.1	0.00	
Malakoff Mine *[1]	92	54	72.2	0.00	
Mammoth Tank *[8]	115	81	99.4	0.00	
Manzana	105	50	77.2	T.	
Mare Island L. H	......	......	......	0.00	
Merced *[5]	109	56	84.0	0.00	
Mills College	......	......	......	0.00	
Milton (near) *[1]	104	63	77.2	0.00	
Modesto *[8]	108	63	85.1	0.00	
Mohave *[8]	113	65	86.6	0.00	
Mokelumne Hill *[8]	......	58	80.0	0.00	
Monterey *[8]	72	50	59.7	0.00	
Mount Breckenridge	......	......	......	0.00	
Mount Frazier	......	......	......	0.02	
Napa *b*	102	46	67.0	0.00	
Needles	113	70	94.8	0.00	
Newcastle *a* †	104	51	78.2	0.00	
Newhall *[8]	109	60	76.5	0.00	
Nordhoff	......	......	......	0.00	
North Ontario	95	52	73.0	0.00	
North San Juan *[1]	99	56	72.8	0.00	
Oakland *a*	84	50	63.0	T.	
Ogilby *[8]	118	90	99.9	0.00	
Oleta *[1]	100	54	74.2	T.	
Orangevale †	110	50	81.2	0.00	
Orland *[8]	109	65	87.4	0.00	
Palermo †	112	45	78.4	0.00	
Paso Robles *b*	101	46	71.0	0.00	
Peachland	93	50	65.4	T.	
Piedras Blancas L. H	......	......	......	0.00	
Pigeon Point L. H	......	......	......	0.00	
Pilot Creek	......	......	......	T.	
Placerville	102	45	74.6	0.00	
Point Ano Nuevo L. H	......	......	......	0.00	
Point Arena L. H	......	......	......	0.00	
Point Bonita L. H	......	......	......	0.00	
Point Conception L. H	......	......	......	0.00	
Point Fermin L. H	......	......	......	0.00	
Point George L. H	......	......	......	0.00	
Point Hueneme L. H	......	......	......	0.00	
Point Lobos	68	48	55.8	0.00	
Point Loma L. H	......	......	......	0.00	
Point Montara L. H	......	......	......	0.00	
Point Pinos L. H	......	......	......	0.00	
Point Reyes L. H	......	......	......	0.00	
Point Sur L. H	......	......	......	0.00	
Pomona (near)	97	50	72.8	0.00	
Poway *[3]	92	62	67.0	0.00	
Quincy †	92	36	63.9	0.00	
Ravenna *[8]	106	57	78.3	0.40	
Redding *b* †	103	57	80.6	T.	
Represa	102	56	77.2	0.00	
Riovista	107	54	76.7	0.00	
Roe Island L. H	......	......	......	0.00	
Rosewood	106	52	78.4	T.	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
California—Cont'd.	°	°	°	Ins.	Ins.
Sacramento *a*	103	52	75.0	0.00	
Salinas*[8]	92	50	65.8	0.00	
San Bernardino†	102	48	74.8	T.	
San Jose *b*	92	42	65.6	0.00	
San Leandro*[1]	90	56	62.3	0.00	
San Luis L. H.	.....	.....	.....	0.00	
San Mateo*[6]	90	58	70.5	0.00	
San Miguel*[8]	105	52	76.3	0.00	
Santa Barbara *a*	81	51	65.3	0.00	
Santa Barbara L. H.	.....	.....	.....	0.00	
Santa Clara *a*	.....	.....	.....	0.00	
Santa Cruz *b* †	89	41	61.8	0.00	
Santa Cruz L. H.	.....	.....	.....	0.00	
Santa Maria	87	47	66.5	0.03	
Santa Monica*[8]	84	63	71.9	0.00	
San Paula *b*	86	46	65.1	0.00	
Santa Rosa*[8]	96	49	70.6	0.00	
Saticoy	.....	.....	.....	T.	
Shasta	.....	.....	.....	0.00	
Sierra Madre	94	51	71.0	0.06	
S. E. Farallone L. H.	.....	.....	.....	0.00	
Stanford University	98	46	67.2	0.00	
Stockton *a*	101	52	75.2	0.00	
Summerdale†	91	45	68.0	0.00	
Susanville†	93	50	70.5	0.00	
Sutter Creek*[5]	100	42	70.5	0.00	
Tehama*[8]	107	64	86.4	0.00	
Templeton*[8]	104	50	71.7	0.00	
Trinidad L. H.	.....	.....	.....	0.10	
Truckee*[8]	88	45	63.6	0.00	
Tulare *b*	.....	.....	.....	0.00	
Tulare *c*	112	50	81.0	0.00	
Turlock†	112	43	79.4	0.00	
Ukiah†	100	48	71.4	T.	
Upper Lake	102	47	73.6	0.05	
Upper Mattole*[1]	90	51	66.1	0.00	
Vacaville *a**[1]	108	57	78.5	0.00	
Ventura†	85	42	62.2	0.00	
Volcano Springs*[8]	123	70	93.9	T.	
Walnut Creek	108	55	78.0	0.00	
West Palmdale	.....	.....	.....	0.98	
Westpoint†	.....	.....	.....	0.00	
Wheatland†	109	51	79.0	0.00	
Williams*[8]	106	65	83.0	0.00	
Wilmington*[5]	89	63	75.7	0.00	
Wire Bridge*[5]	105	58	80.7	0.00	
Yerba Buena L. H.	.....	.....	.....	0.00	
Yreka†	99	38	68.0	0.00	
Yuba City*[5]	105	58	79.9	0.00	
Colorado.					
Alma†	74	27	47.7	1.22	
Antlers†	95	39	69.2	1.34	
Arkins	.....	.....	.....	2.42	
Boulder	90	48	70.6	3.09	
Boxelder	.....	.....	.....	4.03	
Breckenridge†	78	27	51.8	1.70	4.7
Canyon†	104	41	73.6	1.55	
Castlerock	97	37	69.2	3.59	
Cheyenne Wells	103	48	74.0	4.19	
Collbran	.....	.....	.....	1.26	
Colorado Springs†	91	40	66.4	3.34	
Cope	102	45	73.7	1.68	
Crook	105[d]	43	72.4	1.54	
Delta	104	38	72.0	0.90	
Dumont†	85	36	61.2	2.55	
Durango	90	36	65.9	1.38	
Fleming	.....	.....	.....	1.25	
Fort Collins†	95	39	66.8	2.65	
Fort Morgan	100[e]	46[e]	71.0[e]	.....	
Fox	.....	.....	.....	1.59	
Garnett	86	29	60.5	0.90	
Gleneyrie†	86	36	64.2	3.25	
Grand Junction†	97	50	76.2	0.98	
Greeley†	95	42	68.3	2.98	
Grover	.....	.....	.....	2.90	
Gulch†	86	29	60.9	3.84	T.
Gunnison	89	26	60.0	2.01	
Hoehne	94	40	70.2	2.05	
Holly	.....	.....	.....	2.40	
Holyoke (near)	.....	.....	.....	1.22	
Hugo (near)	95	37	66.8	1.35	
Husted†	95	35	66.5	3.00	
La Jara	86	34	59.8	.....	
Lake Moraine†	75	32	53.0	3.61	T.
Lamar†	109	48	78.4	1.61	
Laporte	.....	.....	.....	2.51	
Las Animas†	104	45	75.7	1.20	
Leadville (near)*†[1]	77	30	51.8	1.45	3.0
Leroy†	101	46	72.0	1.39	
Longmont†	96	40	68.2	2.31	
Longs Peak	78	35	54.5	1.85	
Meeker†	98	32	65.2	3.71	
Millbrook†	86	26	59.6	2.26	
Minneapolis†	104	47	77.2	4.65	
Montrose†	92	37	67.8	1.89	
Moraine†	82	35	59.2	2.52	

Stations	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Colorado—Cont'd.	°	°	°	Ins.	Ins.
Pagoda†	92	29	61.4	2.51	
Paonia†	.....	.....	.....	1.05	
Parachute†	94	33	67.0	0.80	
Pinkhamton*[1]	86	37	62.9	2.41	
Rangely†	101	34	70.1	0.82	
Redcliff	.....	.....	.....	1.65	
Rico†	86	27	56.4	2.41	T.
Ruby	.....	.....	.....	2.63	10.0
Saguache†	84	36	63.2	0.45	
St. Cloud	.....	.....	.....	1.31	
San Luis†	93	35	63.1	1.71	
Santa Clara*[1]	89	36	62.0	1.13	
Seibert†	.....	.....	.....	2.53	
Sherwood Ranch	81[1]	33[1]	56.0[1]	.....	
Smoky Hill Mine	87	33	60.0	3.65	
Springfield	.....	.....	.....	1.99	
Stamford*[1]	82	24	50.3	2.28	
Steamboat Springs	99	32	61.4	0.90	T.
Surface Creek†	93	36	67.2	0.82	
Thon†	100	36	68.1	1.91	
T. S. Ranch†	92	44	70.0	1.73	
Twin Lakes	.....	.....	.....	1.00	
Vilas	.....	.....	.....	0.12	
Walden	85	21	59.6	0.93	
Wallet†	.....	.....	.....	2.68	
Wray†	105	48	74.6	1.79	
Yuma	.....	.....	.....	1.78	
Connecticut.					
Bridgeport	91	58	72.8	18.77	
Canton†	89	54	69.4	16.96	
Colchester	88	55	70.8	10.82	
Falls Village	.....	.....	.....	10.57	
Middletown	92	57	73.2	13.35	
New London†	84	57	69.5	6.22	
Norwalk	92	58	72.0	10.12	
Southington*[1]	88	58	71.2	19.90	
Storrs	89	53	69.6	12.24	
Voluntown†	88	53	71.1	8.53	
Waterbury	90	56	71.7	18.10	
West Cornwall†	87	51	69.0	9.71	
Windsor	91	57	72.4	15.29	
Delaware.					
Milford	94	63	76.6	8.63	
Millsboro	92	61	75.8	8.16	
Newark	92	59	75.4	8.70	
District of Columbia.					
Distributing Reservoir*[5]	91	69	78.3	5.77	
Receiving Reservoir*[5]	90	66	78.3	5.66	
West Washington	93	59	77.0	5.88	
Florida.					
Amelia†	99	64	82.1	4.65	
Archer†	99	62	84.0	7.95	
Bartow	97	70	82.9	14.55	
Boca Raton†	91	69	81.2	7.58	
Brooksville†	94	70	81.6	11.98	
Carrabelle†	96	62	82.0	7.10	
Clermont†	99	70	83.1	7.82	
De Funiak Springs	96	62	81.6	3.96	
Earnestville†	97	70	82.9	11.33	
Emerson†	98	68	82.1	5.49	
Eustis†	95	69	82.2	6.21	
Federal Point†	96	63	80.8	7.05	
Fort Meade†	93	64	79.6	11.81	
Frostproof	98	68	81.2	8.94	
Gainesville	101	60	83.1	7.18	
Grasmere†	99	68	83.1	7.28	
Haywood	96	64[e]	82.6[e]	8.30	
Huntington	99	68	83.0	8.56	
Kissimmee	98	68	83.6	5.70	
Lake Butler†	98	67	82.8	3.23	
Lake City†	96	66	83.2	2.69	
Macclenny†	102	64	82.8	6.49	
Manatee	.....	.....	.....	11.74	
Merritts Island	95	74	82.7	2.59	
Milton*[1]	98	70	82.8	3.95	
Mullet Key†	94	75	85.0	7.67	
Myers†	92	70	80.4	14.82	
New Smyrna	93	66	80.6	9.94	
Oakhill*[1]	94	77	83.1	.....	
Ocala*†[1]	95	73	80.5	7.03	
Orange City	99	69	83.0	2.89	
Orange Park	97	65	81.9	5.18	
Orlando†	99	68	79.6	9.26	
Oxford*†[1]	96	73	82.4	9.80	
St. Francis†	97	61	79.6	6.36	
St. Francis Barracks	99	68	81.4	3.05	
Sebastian	95	70	82.4	3.75[b]	
Switzerland*[1]	100	72	81.4	9.07	
Tallahassee†	97	62	81.6	6.13	
Tarpon Springs†	96	69	81.8	10.55	
Georgia.					
Adairsville†	102	56	78.8	8.62	
Alapaha	104	59	82.9	3.17	
Albany†	106	61	83.9	7.53	
Allentown†	100	61	81.7	5.38	
Americus†	100	60	83.6	2.50	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Georgia—Cont'd.	°	°	°	Ins.	Ins.
Athens†	100	58	79.6	3.19	
Bainbridge†	102	62	83.2	7.74	
Belleville	104	62	82.4	7.53	
Blakely†	99	67	82.6	4.11	
Brag	102	56	80.4	4.84	
Camak†	101	62	81.6	3.42	
Canton†	.....	.....	.....	5.85	
Cartersville[d]	98	57	77.8	7.61	
Cedartown	100	55	78.8	7.84	
Clayton†	95	52	75.4	9.07	
Columbus	100	60	82.1	4.97	
Cordele	99	64	84.7	.....	
Covington	102	57	76.2	3.52	
Crescent	104	66	83.0	6.80	
Dahlonega†	95	54	75.0	8.27	
Diamond	94	46	74.0	5.92	
Eastman†	101	62	81.4	7.90	
Elberton†	100	59	80.0	5.33	
Fleming†	103	57	80.8	5.37	
Fort Gaines	98	60	81.3	10.08	
Franklin	96	60	80.2	5.04	
Gainesville	95	58	76.5	14.43	
Gillsville†	100	57	78.7	10.94	
Greenbush	100	53	76.8	7.73	
Griffin†	103	57	80.6	6.11	
Hephzibah*†[6]	100	70	80.2	6.15	
Jesup	102[f]	60[f]	82.4[f]	2.95	
Lagrange†	98	60	81.0	7.86	
Leverett	107	58	81.5	7.53	
Louisville	104	59	81.8	4.55	
Lumpkin	95	65	81.7	2.07	
Macon† *b*	102	63	81.8	5.10	
Marietta	97	58	76.9	8.41	
Marshallville†	97	67	82.1	3.20	
Milledgeville†	99	70	83.6	1.85	
Millen	100	59	82.6	5.37	
Monticello*[1]	95	73	82.0	3.75	
Morgan†	100	55	81.2	2.61	
Newnan†	102	60	81.5	5.29	
Point Peter	100	58	79.7	4.37	
Poulan†	101	56	81.7	2.91	
Quitman†	101	60	82.6	6.66	
Ramsey	98	52	75.0	8.05	
Rome†	101	57	78.8	7.68	
Sparta	105	60	81.8	2.31	
Talbotton†	94[d]	59[d]	79.1[d]	5.41	
Tallapoosa	99	57	78.2	6.15	
Thomasville†	99	62	82.4	4.18	
Toccoa†	100	60	77.8	6.03	
Union Point	98	60	81.6	5.60	
Washington†	104	60	81.9	6.16	
Waycross	102	62	82.6	3.45	
Waynesboro	100	60	80.0	3.61	
Westpoint	102	61	82.4	5.37	
Idaho.					
American Falls	103	39	69.6	0.43	
Blackfoot†	100	32	67.3	1.84	
Boise Barracks†	107	40	70.6	0.16	
Burnside†	93	35	64.2	T.	
Challis	100	34	64.4	0.52	
Cœur d'Alene	99	41	65.2	.....	
Corral*†[1]	93	45	62.8	0.06	
Downey	97	32	63.2	0.20	
Fort Sherman†	96	41	63.5	1.93	
Gimlet†	95	34	63.2	0.07	
Idaho City	97	33	63.6	1.26	
Junction†	92	28	57.2	0.36	
Kootenai†	98	38	64.8	1.47	
Lewiston†	106	44	69.4	0.83	
Lost River†	.....	.....	.....	0.51[e]	
Martin†	89	27	59.4	T.	
Marysville	93	29	61.6	1.80	
Minidoka	108	30	66.7	0.10	
Murray†	92	36	58.6	2.43	
Nampa	107	39	69.3	0.23	
Ola†	100	39	66.2	0.21	
Payette†	104	40	71.5	0.70	
Pollock†	105	40	68.2	0.63	
Rexburg	96	34	64.8	1.69	
St. Maries	94	40	61.6	2.14	
Salubria	102	38	68.4	0.22	
Soldier†	97	30	62.8	0.13	
Swan Valley†	95	27	61.6	0.50	
Warren†	98	31	58.6	0.77	
Illinois.					
Albion†	99	55	79.4	4.82	
Alexander†	103	53	78.6	2.41	
Ashton*†[1]	100	59	77.8	0.99	
Atwood *a**†[2]	106	50	73.4	7.65	
Atwood *b*	.....	.....	.....	4.89	
Aurora *a*	108	50	78.6	4.45	
Aurora *b*	101	52	77.0	5.01	
Bloomington†	104	51	78.6	3.91	
Bushnell†	102	49	80.2	4.68	
Cambridge	97	54	76.6	2.41	
Carlinville†	100	54	79.0	3.33	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Illinois—Cont'd.	°	°	°	*Ins.*	*Ins.*
Carlyle	......	......	......	4.23	
Carrollton	93	60	76.7	6.54	
Charleston	96	54	77.4	1.96	
Chemung	96	49	72.8	4.73	
Chester	......	......	......	3.05	
Cisne†	95	54	77.2	6.93	
Clearcreek†	101	49	76.7	2.92	
Coatsburg†	94	53	76.0	7.95	
Cobden†	99	52	78.7	2.99	
Cordova	......	......	......	2.47	
Danville	101	51	77.8	2.12	
Decatur†	101	52	77.3	3.03	
Dixon†	100	53	76.8	1.97	
Dwight†	99	50	76.2	2.50	
East Peoria†	101	50[k]	77.6[f]	4.71	
Effingham†	98	55	78.0	2.11	
Evanston *[10]	96	58	75.0	......	
Fort Sheridan†	95	50	73.2	1.34	
Friendgrove *†[4]	......	60	77.9	2.49	
Galva†	98	52	76.4	3.60	
Glenwood *†[1]	99	60	75.2[e]	1.12	
Golconda†	103	55	80.6	3.84	
Grafton†	......	......	......	3.73	
Greenville†	100	54	78.7	5.69	
Griggsville†	98	55	78.0	......	
Halliday *[5]	100[d]	68[d]	84.4[d]	2.32	
Havana†	97	53	77.4	5.22	
Herrin *[1]	98	55	80.6	2.66	
Hillsboro†	97	55	78.0	5.16	
Joliet†	103	55	77.4	1.59	
Jordans Grove†	98	54	78.6	0.93	
Kankakee *a*†	93	55	73.7	2.15	
Kishwaukee	97	50	74.7	2.89	
Knoxville *a*	97	53	76.3	4.45	
Lagrange†	95	52	73.8	2.97	
Laharpe *[1]	98	54	78.6	3.87	
Lanark *†[1]	98	50	72.5	1.06	
Lexington	100	52	76.4	6.38	
Loami†	......	......	......	4.41	
Louisville†	95	55	76.5	2.95	
McLeansboro†	99	56	78.6	3.43	
Martinsville†	96	55	77.0	2.30	
Martinton†	101	51	77.4	1.67	
Mascoutah *[5]	100	58	80.0	3.27	
Mattoon *[1]	95	55	78.1	3.63	
Minonk†	104	51	76.4	2.93	
Monmouth†	96	53	76.1	5.26	
Morgan Park	95	52	73.2	......	
Morrisonville†	95	53	76.1	3.60	
Mount Carmel†	......	......	......	3.10	
Mount Pulaski	96	51	75.8	3.10	
Mount Vernon	100	56	80.0	3.00	
New Burnside†	102	54	80.1	5.81	
Olney *a* *[1]	100	53	80.4	......	
Oswego *[1]	97	56	75.3	3.63	
Ottawa†	99	54	77.2	2.99	
Palestine†	98	55	77.8	2.08	
Paris	104	52	78.4	2.70	
Peoria *a*†	......	......	......	5.90	
Peoria *b*†	101	53	78.6	4.65	
Philo†	100	50	75.8	3.48	
Plumhill†	99	55	78.8	3.91	
Rantoul†	100	52	76.0	5.39	
Reynolds	99	52	76.2	4.05	
Riley†	95	51	74.4	1.57	
Robinson *†[3]	100	60	76.2	2.79	
Roundgrove†	103	52	77.6	3.05	
St. Charles *†[1]	96	58	76.1	3.41	
St. John *†[1]	101	65	80.8	1.91	
Scales Mound	99	48	74.4	2.70	
Streator†	98	58	77.4	2.71	
Sycamore†	96	51	74.6	3.03	
Tiskilwa *†[3]	100	61	76.3	2.38	
Tuscola†	100	52	76.4	5.39	
Walnut†	102	50	78.8	1.35	
Wheaton *[3]	......	63	74.8	3.09	
Winnebago†	97	51	74.6	3.82	
Zion†	95	48	73.6	2.22	
Indiana.					
Anderson†	99	53	76.4	2.61	
Angola *[1]	103	56	75.2	2.76	
Auburn	100	53	76.0	1.75	
Bloomington†	100	56	78.2	2.62	
Bluffton†	103	53	77.0	1.08	
Bright†	96	55	76.3	6.33	
Butlerville†	98	52	76.0	6.54	
Cambridge City†	99	52	75.3	4.29	
Columbia City *[1]	98	57	76.4	1.29	
Columbus†	97	51	74.7	6.25	
Connersville†	98	53	75.1	3.56	
Delphi†	102	51	77.2	2.10	
Edwardsville *†[1]	94	57	77.6	2.06	
Evansville†	98	56	78.7	9.09	
Farmland†	96	54	75.4	2.62	
Fort Wayne	100	57	75.4	1.42	
Greencastle†	94	54	75.8	3.46	
Indiana—Cont'd.	°	°	°	*Ins.*	*Ins.*
Greensburg	96	57	79.4	7.24	
Hammond†	99	44	75.4	0.74	
Huntington	100	54	77.0	2.15	
Jasper†	99	55	78.0	3.40	
Jeffersonville	97	56	78.3	7.39	
Knightstown†	99	52	76.7	3.09	
Knox	99	54	77.7	2.50	
Kokomo†	104	53	77.2	1.05	
Laconia	101	55	79.5	1.32	
Lafayette†	99	51	76.3	2.79	
Laporte	102	50	73.9	3.43	
Logansport *b*†	102	54	77.8	1.28	
Madison†	98	55	78.1	4.78	
Marengo†	99	53	77.8	3.57	
Marion†	101	53	76.5	3.24	
Mauzy†	96	53	75.5	4.66	
Mount Vernon†	100	57	79.4	5.18	
Northfield†	97	53	75.6	1.78	
Princeton *[1]	100	56	77.9	3.75	
Richmond	98	51	76.0	3.04	
Rockville†	97	52	75.9	3.96	
Salem	103	53	77.0	4.09	
Scottsburg	99	56	78.4	4.87	
Seymour	99	55	77.4	6.35	
Shelbyville	102	55	78.9	4.13	
South Bend†	101	52	76.2	1.75	
Syracuse†	......	......	......	1.47	
Terre Haute†	98	57	79.1	3.68	
Tipton†	100	53	77.4	1.42	
Topeka†	97[i]	54	75.2[f]	1.05	
Valparaiso†	96	54	75.9	1.10	
Vincennes†	102	56	80.2	4.59	
Warsaw†	98	53	76.2	2.21	
Washington†	99	55	78.7	4.36	
Worthington†	98	53	77.2	1.96	
Indian Territory.					
Healdton† [k]	101	52	83.1	2.05	
Kemp†	......	......	......	1.83	
Lehigh†	104	54	82.9	3.01	
Purcell† [e]	103	55	81.2	2.87	
South McAlester†	......	......	......	2.45	
Tulsa†	......	......	......	3.72	
Wagoner	109	59	83.8	3.22	
Iowa.					
Adair	......	......	......	4.04	
Afton	105	52	77.8	1.89	
Algona *[1]	96	58	75.8	3.52	
Alta *a*†	96	50	74.5	5.19	
Amana†	100	51	75.9	4.28	
Ames *b*	100[k]	51	77.5[f]	2.45	
Ames (near)	......	......	......	4.13	
Atlantic†	102	44	73.8	2.39	
Atlantic (near)	99	52	76.8	3.26	
Audubon	99	43	73.4	3.52	
Belknap	98	52	76.4	3.55	
Belleplaine	100	47	73.0	4.59	
Bonaparte†	99	52	77.6	2.83	
Britt	97	48	72.6	3.80	
Carroll	102	45	75.6	2.76	
Cedarfalls	99	52	75.8	6.25	
Cedar Rapids†	102	52	76.4	4.35	
Centerville	101	56	78.0	5.04	
Chariton	98	53	77.1	1.74	
Charles City	98	48	74.6	3.42	
Clarinda†	100	56	78.8	2.63	
Clinton	99	54	77.0	1.69	
College Springs	103	52	79.0	2.82	
Corning†	99	49	76.6	1.90	
Council Bluffs	103	54	78.8	1.82	
Cresco†	94	49	72.1	2.12	
Decorah†	97	49	73.6	1.89	
Delaware *[3]	97	54	73.9	1.94	
Denison†	96	50	73.4	4.54	
Dows	95	48	73.5	1.18	
Eldora	101	52	76.0	2.92	
Elkader†	100	46	74.4	2.42	
Fairfield†	96	49	75.8	3.62	
Fayette†	98	53	74.4	2.85	
Fonda	101	51	74.8	5.07	
Forest City	95	52	72.2	4.59	
Fort Madison *†[1]	94	64	79.3	5.91	
Fredericksburg	......	......	......	1.69	
Galva†	101	45	76.2	2.72	
Gardengrove	102	47	76.0	2.16	
Gladbrook	......	......	......	2.93	
Glenwood†	103	44	78.0	1.31	
Grand Meadow *[1]	92	54	70.9	4.30	
Greene	102	47	75.1	4.04	
Greenfield	99	49	76.2	2.82	
Grundy Center	98	53	74.1	3.61	
Guthrie Center	98	47	75.0	5.00	
Hampton	97	50	74.4	1.30	
Hawkeye	......	......	......	2.95	
Hedrick	97	61[e]	76.8	3.70	
Hopeville†	99	52	76.5	1.20	
Humboldt†	100	47	75.6	2.64	
Iowa—Cont'd.	°	°	°	*Ins.*	*Ins.*
Independence†	96	49	72.2	2.42	
Indianola†	98	50	76.4	2.39	
Iowa City *a*†	100	52	76.9	3.83	
Iowa City *b*	93	54	74.1	......	
Iowa Falls†	100	45	74.2	2.11	
Keosauqua	97	56	78.2	4.45	
Knoxville	98	53	77.0	3.05	
Lansing	98	49	75.0	2.66	
Larchwood	......	......	......	4.27	
Larrabee†	97	47	73.3	4.61	
Leclaire	......	......	......	1.88	
Lemars	99	46	75.8	2.09	
Lenox *[1]	97	61	76.2	4.06	
Logan†	105	47	76.4	1.38	
Malvern *[1]	106	50	76.9	1.17	
Maple Valley	......	......	......	4.30	
Maquoketa	98	53	76.4	2.12	
Marshall†	99	50	75.1	2.87	
Mason City	98	45	70.6	4.01	
Millman	......	......	......	3.48	
Mooar	97	52	77.4	6.94	
Mountayr†	101	52	77.2	2.25	
Mount Pleasant *[1]	92	60	78.8	4.60	
Mount Vernon *a* *[1]	99	58	77.4	2.95	
Mount Vernon *b*	99	51	75.1	5.86	
Neola	103	47	78.2	3.05	
New Hampton	98	52	75.2	2.00	
Newton†	99	50	76.3	2.17	
North McGregor	......	......	......	4.95	
Northwood	96	53	72.8	4.31	
Odebolt	......	......	......	4.03	
Ogden	99	47	75.2	2.13	
Osage *†[3]	......	57	72.0	3.51	
Osceola	100	52	77.0	1.01	
Oskaloosa†	98	49	75.9	3.25	
Ottumwa	98	54	77.5	2.53	
Ovid†	100	54[f]	77.8[e]	1.57	
Plover	97	49	74.8	4.22	
Primghar	97	49	74.0	2.96	
Red Oak	100	49	76.0	2.81	
Rock Rapids	100	43	72.6	2.67	
Rockwell City	101	42	75.8	2.27	
Sac City†	97	48	74.1	3.40	
St. Charles	97	53	76.4	3.67	
Seymour†	100	50	78.0	2.25	
Sibley	98	43	72.5	6.21	
Sidney	100	57	78.6	2.25	
Sigourney	100	54	78.4	4.08	
Spencer	98	47	73.6	4.81	
Spirit Lake†	99	50	74.1	5.08	
Stuart	98	52	76.1	7.60	
Thurman	100	48	78.4	1.50	
Toledo	98	50	75.2	2.26	
Villisca†	98	49	76.2	1.79	
Vinton *[1]	97	55	75.6	2.40	
Washington	99	50	75.8	6.23	
Washta	......	......	......	2.67	
Waterloo	100	50	74.9	4.16	
Waukee	97	48	73.1	4.35	
Waverly	97	53	74.8	3.32	
Webster City	97	50	75.7	1.76	
Westbend *†[1]	96	57	73.6	4.15	
Whitten *[1]	98	60	74.7	2.63	
Wilton Junction†	100	51	76.5	3.19	
Winterset†	97	50	74.0	5.43	
Kansas.					
Abilene†	105	53	80.9	3.74	
Achilles *[3]	107[e]	64	74.3[e]	2.83	
Altoona *†[3]	101	60	79.2	2.44	
Anthony	......	......	......	0.83	
Assaria *[5]	106	62	84.6	2.30	
Atchison†	99	55	78.5	3.60	
Baker	101	56	80.5	2.14	
Beloit†	105	54	80.0	3.96	
Burlington†	103	53	81.2	1.41	
Campbell	103	53	79.6	4.34	
Chanute	94[e]	56[e]	79.6[e]	3.29	
Colby†	103	46	76.0	1.83	
Columbus	100	53	79.8	4.10	
Coolidge†	107	50	78.0	2.50	
Cunningham†	109	52	81.0	2.93	
Dresden *[1]	103	60	77.4	2.67	
Elgin *[1]	101	64	81.0	3.97	
Ellinwood†	105	51	80.2	3.09	
Emporia†	105	58	82.0	0.70	
Englewood†	106	50	79.7	2.07	
Eskridge	......	......	......	2.12	
Eureka†	......	......	......	1.26	
Eureka Ranch†	107	52	79.5	3.28	
Fall River	99	53	80.6	5.84	
Fort Riley†	102	56	80.8	3.69	
Fort Scott†	101	55	80.2	2.35	
Frankfort	106	50	80.3	3.25	
Garden City†	103	52	78.2	3.49	
Garfield	......	......	......	1.35	
Gibson	103	52	78.0	4.76	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Kansas—Cont'd.	°	°	°	*Ins.*	*Ins.*
Goodland	108	45	78.6	2.54	
Gove*†[1]	103	59	79.2	4.77	
Grainfield*[6]	104	55	77.8	3.75	
Grenola	101	51	79.2	4.62	
Halstead	100	50	77.4	1.56	
Hays†	......	......	......	2.83	
Horton	102	55	79.2	2.36	
Hutchinson†	103	54	80.4	3.43	
Independence†	105	56	82.1	7.03	
Lakin†	110	42	80.2	2.25	
Lawrence	100	58	79.0	1.70	
Lebo†	103	52	80.9	0.93	
Linn	......	......	......	6.20	
Macksville	105	54	79.4	3.35	
McPherson	103	52	79.5	7.13	
Manhattan *b*	104	54	80.8	3.44	
Manhattan *c*	102	52	78.8	3.97	
Marion†	......	......	......	1.98	
Meade†	......	......	......	2.55	
Medicine Lodge†	108	53	82.8	1.84	
Minneapolis†	107	52	81.2	2.00	
Morantown†	100	53	79.9	1.26	
Morland	102	49	76.7	3.75	
Mounthope*[1]	102	65	82.2	1.44	
Ness City	......	53	......	3.75	
Newton	104	50	80.8	1.71	
Norton	104	47	75.5	2.09	
Norwich†	105[j]	61[j]	83.6[j]	1.18	
Oberlin†	......	......	......	2.65	
Olathe†	105	53	80.0	1.40	
Osage City†	103	52	80.1	2.01	
Osborne	......	......	......	2.62	
Oswego	102	54	81.7	6.26	
Ottawa	103	53	79.0	1.00	
Pleasant Dale	107	53	80.8	1.35	
Pratt	108	53	82.6	0.05	
Rome*†[1]	102	53	79.6	1.52	
Russell	106	......	......	2.50	
Salina†	107	55	82.5	2.91	
Scott City	106	50	77.5	3.84	
Sedan†	103	52	81.2	4.06	
Seneca	100	50	78.5	2.97	
Sharon Springs*[1]	108	55	82.0	3.75	
Toronto	103	49	80.2	3.17	
Ulysses†	107[f]	48[f]	79.4[f]	1.85	
Viroqua†	107	51	80.8	1.45	
Wallace*[1]	111	52	80.0	2.72	
Wamego*[1]	104	58	80.0	4.87	
Wellington*[1]	98	58	80.7	1.40	
Winona*[6]	106	57	76.0	4.50	
Yates Center	101	50	79.6	1.50	
Kentucky.					
Alpha†	96	55	76.6	9.05	
Ashland	102	54	77.2	4.50	
Bardstown†	98	54	78.0	8.49	
Blandville†	98	53	79.1	3.48	
Bowling Green *a**[1]	101	54	76.6	3.76	
Bowling Green *b*†	102	60	80.7	2.98	
Burnside†	......	......	......	4.77	
Caddo†	98	54	76.6	6.59	
Canton*†[1]	101	60	79.0	3.82	
Carlisle	101	55	76.0	3.11	
Carrollton†	102	56	79.8	5.89	
Catlettsburg†	......	......	......	5.90	
Earlington	95	58	77.5	4.65	
Edmonton†	95	53	76.4	4.90	
Ensor	100	55	79.1	0.82	
Eubank†	97	50	75.3	6.37	
Falmouth†	......	......	......	5.82	
Fords Ferry†	102	54	79.5	4.94	
Frankfort†[h]	101	54	77.6	3.12	
Georgetown	95	57	77.3	......	
Greensburg†	103	52	79.2	4.90	
Henderson†	99	59	79.6	7.23	
Hopkinsville†	100	56	79.8	2.44	
Irvington	......	......	......	1.51	
Leitchfield†	101	55	78.2	2.86	
Loretto	97	53	76.6	6.10	
Lyndon	......	......	......	5.18	
Marrowbone†	98	51	77.2	8.59	
Maysville	100	53	77.8	5.15	
Middlesboro†	96	53	75.0	5.33	
Mount Herman	96	56	76.9	6.37	
Mount Sterling†	95	56	76.0	3.09	
Owensboro†	95	55	77.3	2.17	
Owenton†	99	55	77.8	4.07	
Paducah *a*†	......	......	......	4.11	
Paducah *b*†	103	59	81.8	3.83	
Pilot Oak	107	51	81.6	......	
Pleasure Ridge Park†	98	55	77.8	2.28	
Princeton	101	55	80.0	4.60	
Richmond†	98	53	76.4	5.90	
Russellville†	100	57	79.6	5.25	
St. John†	95	54	75.4	2.71	
Sandyhook	......	......	......	5.54	
Scott	100	55	80.8	5.10	

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Kentucky—Cont'd.	°	°	°	*Ins.*	*Ins.*
Sergent	......	......	......	4.60	
Shelby City	......	......	......	4.83	
Shelbyville†	101	55	78.1	5.91	
Southfork[2]	......	......	73.2	7.53	
Vanceburg	99	55	75.8	4.15	
Williamsburg†	97	55	77.2	7.80	
Louisiana.					
Abbeville	96	66	82.0	6.75	
Alexandria†	100	62	82.6	3.40	
Amite†	102	63	83.8	8.09	
Bastrop†	99	59	83.5	2.42	
Baton Rouge†	97	62	82.5	5.38	
Calhoun[f]	100	60	84.0	3.32	
Cheneyville†	98	62	82.2	4.53	
Clinton†	100	62	82.2	3.73	
Como[e]	98	64	82.0	7.29	
Covington	98	60	82.8	3.30	
Donaldsonville†	98	65	83.0	5.39	
Elm Hall	94	60	79.1	7.63	
Emilie†	95	65	81.7	3.91	
Franklin†	98	66	83.2	5.26	
Grand Coteau	94	65	80.9	2.11	
Hammond	97	59	81.8	5.02	
Houma	96	63	82.6	5.82	
Jeanerette	100	64	82.9	7.92	
Lafayette†	97	64	82.0	3.32	
Lake Charles†	99	66	83.6	2.04	
Lake Providence	102[f]	62[f]	83.5[f]	......	
Lawrence	99	61	84.6	4.72	
Liberty Hill	104	59	85.2	2.00	
Mansfield†	102	58	83.1	1.43	
Melville	96	66	82.8	2.70	
Minden	102	63	84.8	1.14	
Monroe†	100	62	84.7	1.30	
Montgomery	104	63	84.4	4.20	
New Iberia	95	70	82.7	7.23	
Oakridge†	103	56	83.8	5.31	
Oberlin	98	64	82.5	2.50	
Opelousas†	98	54	81.3	2.03	
Oxford†	97	59	81.8	3.83	
Paincourtville†	97	60	82.2	4.14	
Plain Dealing†	101	65	84.5	2.45	
Rayne	100	66	83.4	4.68	
Robeline	101	58	82.1	0.44	
Ruston	99	64[d]	85.2	3.41	
Schriever	99	62	83.1	6.99	
Shellbeach	97	72	84.0	3.37	
Southern University†	92	65	80.2	2.45	
Sugar Ex. Station†	96	66	83.3	3.03	
Sugartown†	97	66	87.0	0.90	
Venice†	97	68	81.4	2.93	
Wallace	96	66	82.3	4.49	
Whitehall	101	61	82.8	5.82	
White Sulphur Springs	101	63	84.2	3.77	
Maine.					
Bar Harbor	91	40	64.8	5.62	
Belfast*[6]	82	54	65.2	3.19	
Cornish*[1]	92	52	69.7	7.19	
Fairfield	93	46	69.4	3.52	
Flagstaff	96[e]	39[e]	68.0[e]	7.77	
Fort Fairfield	95	42	66.3[b]	6.15	
Gardiner	97	49	71.8	3.15	
Kineo†	89	50	68.2	8.37	
Lewiston	98	52	71.9	6.63	
Mayfield	95	44	68.2	8.04	
North Bridgton	95	48	70.8	13.25	
Orono	93	43	68.2	2.02	
Maryland.					
Annapolis	93	64	76.8	5.76	
Bachmans Valley	95	56	74.8	5.10	
Boettcherville[2]	......	......	71.6	4.30	
Charlotte Hall†	90	58	76.0	6.78	
Cherryfields†[2]	......	......	76.3	2.78	
Chestertown†	88	60	75.2	8.43	
Collegepark	90[f]	54[f]	73.7[f]	5.29	
Cumberland *b*	98	60	77.2	4.41	
Darlington†	91	58	74.5	6.76	
Deerpark	91	41	67.6	5.13	
Easton†	90	61	76.0	8.30	
Fallston*[1]	88	62	74.4	9.49	
Flintstone	96	50	74.1	3.64	
Frederick	95	59	76.6	7.33	
Grantsville	94	49	72.4	6.16	
Greatfalls*[5]	90	64	77.6	5.06	
Greenspring Furnace	97	53	75.6	4.73	
Hagerstown†	......	59	......	4.69	
Jewell†	89	60	75.6	19.90	
Johns Hopkins Hospital	93	60	76.4	7.93	
Laurel	92	55	75.4	6.70	
Mardela Springs†	90	62	76.9	9.96	
Mount St. Marys Coll.†	92	59	74.3	7.99	
New Market	95	57	76.8	9.48	
Pocomoke City	91	64	78.8	8.09	
Port Deposit	95	61	75.8	7.64	
Princess Anne	86	60	76.0	11.38	
Sharpsburg	94	57	75.2	3.99	

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Maryland—Cont'd.	°	°	°	*Ins.*	*Ins.*
Smithsburg	90	59	74.8	5.52	
Solomons†	92	64	78.6	7.39	
Sunnyside	93	46	68.8	5.51	
Taneytown†	100	57	77.6	7.27	
Van Bibber	98	58	76.0	9.26	
Western Port	102	52	75.6	3.01	
Massachusetts.					
Amherst	92	51	71.8	13.87	
Bluehill (summit)	89	52	69.2	4.86	
Cambridge *a*	94	52	72.6	4.06	
Chestnut Hill	94	52	72.4	4.38	
Concord†	94	52	71.2	4.50	
Fallriver	87	55	70.9	4.60	
Framingham	94	53	72.6	5.34	
Groton	94	50	70.8	6.57	
Hyannis*†[1]	86	56	70.2	4.44	
Lawrence	100	52	74.6	3.02	
Lowell *a*	92	53	72.6	4.62	
Middleboro	88	47	70.8	4.80	
Monson	92	55	71.6	9.45	
New Bedford *a*	83	52	69.8	3.85	
North Billerica	97	52	72.1	3.75	
Springfield Armory	92	49	75.3	14.99	
Taunton *b*	87	51	71.0	5.7[illegible]	
Wakefield	95	52	72.0		
Westboro†	95	51	72.6		
Worcester *b*	92	54	73.4		
Michigan.					
Adrian	100	57	74.8	1.56	
Allegan	99	48	73.6	0.95	
Alma	100	51	73.2	4.63	
Ann Arbor	102	54	75.5	1.66	
Arbela	101	54	73.9	8.11	
Baldwin	100	40	71.8	2.17	
Ball Mountain	95	55	73.0	3.09	
Baraga	99	44	68.8	3.15	
Battlecreek	101	55	76.0	1.69	
Bay City *b*	100	53	73.0	10.10	
Benton Harbor	97	50	74.6	0.16	
Benzonia	98	53	72.0	4.58	
Berlin	97	51	71.3	2.98	
Berrien Springs	98	50	75.0	0.93	
Big Rapids	97	50	71.8	2.01	
Birmingham	101	50	75.2	3.22	
Boon	95	44[e]	69.8	3.21	
Calumet	92	50	67.6	3.80	
Carsonville	97	52	71.7	3.52	
Charlevoix	96	50	71.6	1.75	
Cheboygan	101	50	71.6	2.58	
Clinton	104	52	75.8	2.34	
East Tawas	96	52	71.6	2.99	
Eloise	98	54	73.8	2.91	
Escanaba†	88	51	71.4	2.78	
Ewen	95	47	68.2	......	
Fairview	95	53	73.8	1.78	
Fitchburg	100	50	72.3	3.55	
Flint	99	51	72.5	3.90	
Gladwin	98	52	71.1	3.18	
Grand Rapids *b*	100	55	76.3	1.72	
Grape	98	53	75.4	3.57	
Grayling	101	45	72.6	2.80	
Hanover	102	53	74.4	4.05	
Harrison[e]	99	51	71.4	2.73	
Harrisville	90	52	69.0	4.28	
Hart	99	47	74.8	2.18	
Hastings	100	53	74.1	2.99	
Hayes	97	48	70.8	3.74	
Highland Station	......	......	......	3.93	
Hillsdale	98	53	73.8	2.38	
Holland*[10]	93	51	72.7	......	
Howell	99	54	76.0	6.05	
Humboldt	94	......	......	3.10	
Ionia	102	50	73.7	3.22	
Iron River	94[b]	45[b]	68.6[b]	5.26	
Ivan	98	55	74.1	2.93	
Jackson	103	55	75.8	2.09	
Jeddo	95	53	71.4	5.89	
Kalamazoo	99	55	75.4	2.35	
Lake City	97	43	70.6	3.94	
Lansing	97	55	73.3	7.32	
Lapeer	101	53	72.5	3.13	
Lathrop	92	42[e]	69.4	3.71	
Ludington	90	45	72.1	0.93	
Luzerne	97	48	70.6	3.73	
Mackinaw City	97	50	69.3	1.65	
Madison	100	54	75.4	1.49	
Mancelona	97	46	72.0	1.88	
Manistee	96	45	70.0	1.28	
Manistique	82	48	66.6	2.44	
Mayville	101	42	72.4	5.47	
Middle Island*[10]	86	58	69.3	......	
Midland[3]	......	42	71.6	6.98	
Mottville	103	45	75.2	1.94	
Mount Clemens	101	52	73.1	3.99	
Mount Pleasant *b*	102	53	73.6	3.04	
Muskegon	94	57	74.0	2.47	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
	°	°	°	*Ins.*	*Ins.*
Michigan—Cont'd.					
Newberry	96	46	67.8	3.99	
North Manitou Island *[10]	90	55	68.6	......	
North Marshall	99	52	73.2	2.60	
Northport	96	53	71.4	1.97	
Old Mission	94	52	71.8	1.98	
Olivet	96	55	73.6	6.31	
Omer	100	47	70.8	3.05	
Ovid	100	50	73.6	5.28	
Owosso	101	53	74.0	3.88	
Parkville	......	......	......	3.95	
Petoskey	98	52	73.0	1.55	
Plymouth	101	49	72.9	2.99	
Pontiac	98	55	74.5	2.93	
Port Austin	98	53	70.6	1.05	
Powers	93	45	70.6	3.12	
Reed City	99	42	71.2	2.90	
Rockland	94	46	68.8	3.60	
Rogers City	96	44	68.4	4.40	
Saginaw	101	54	76.6	6.87	
St. Ignace	91	50	70.0	2.42	
St. Johns	100	54	75.4	3.01	
Sandbeach *b*	99	35	67.0	3.02	
Sidnaw	98	40	67.4	2.03	
Somerset	98	53	73.4	2.87	
South Haven	95	49	72.4	0.80	
Stanton	100	54	72.8	3.28	
Sturgeon Point *[10]	83	45	70.0	......	
Thomaston	95	41	69.2	9.40	
Thornville	98	58	74.8	3.56	
Thunder Bay Island *[10]	86	54	69.0	......	
Valley Center	97	49	71.5	5.85	
Vandalia	100	52	76.3	1.80	
Wasepi	97	48	73.3	2.03	
Waverly	99	49	73.6	1.34	
West Harrisville	97	52	70.3	5.14	
Wetmore	94	39	66.4	2.77	
White Cloud	99	50	73.6	3.11	
Ypsilanti	96	53	73.6	3.42	
Minnesota.					
Ada†	90	50	70.2	7.83	
Alexandria†	92	53	71.1	8.19	
Beardsley	95	47	70.6	5.35	
Bermidji	94	......	......	8.60	
Bingham Lake	96	50	74.6	......	
Bird Island	93	53	71.4	6.86	
Blooming Prairie†	95	50	72.1	9.10	
Bonniwell	95	53	73.0	5.62	
Caledonia†	97	49	73.2	2.79	
Camden	98	50	72.1	4.64	
Collegeville	98	55	72.8	6.84	
Crookston†	89	50	70.0	8.45	
Detroit City	92	50	71.0	7.93	
Faribault	97	52	74.2	6.30	
Farmington†	96	52	70.6	4.49	
Fergus Falls†	94	53	71.6	3.00	
Glencoe	94	45	71.6	6.94	
Glenwood†	101	40	72.2	8.37	
Grand Meadow†	95	50	73.0	8.05	
Koochicking	90	46	68.2	6.18	
Lake City	97	49	73.3	4.40	
Lakeside†	93	53	72.2	7.35	
Lake Winnibigoshish [1]	89*	52	68.0	9.87	
Lambert†	90	53	71.3	9.80	
Lawrence	102	46	70.8	5.35	
Leech Lake [1]	92*	50	69.2	6.00	
Lesueur *[1]	98	58	73.7	10.80	
Long Prairie†	95	52	72.1	5.09	
Lutsen	83	46	61.0	9.99	
Luverne†	94	47	72.6	6.59	
Mapleplain	93	56	74.3	4.91	
Maplewood *[1]	92	57	73.5	......	
Mazeppa [1]	104*	46	75.6	4.50	
Milaca	100	50	73.8	12.81	
Milan†	95	50	72.0	3.48	
Minneapolis *a*†	97	53	73.8	4.93	
Minneapolis *b* [1]	95*	50	72.5	4.70	
Minnesota City *†[1]	96	48	73.5	4.79	
Montevideo†	95	52	71.9	4.99	
Morris	95	54	72.7	9.30	
Mount Iron	93	44	67.4	8.75	
New London	95	52	71.4	5.28	
New Richland *[1]	95[d]	58[d]	73.6[d]	......	
New Ulm†	96	52	73.5	4.06	
Park Rapids†	94	48	69.2	10.16	
Pine River [1]	94*	52	70.2	8.02	
Pleasant Mounds†	93	51	71.7	3.64	
Pokegama Falls [1]	93*	46	68.3	7.53	
Redwing	......	......	......	4.51	
Reeds	......	......	......	4.56	
Rolling Green	93	53	72.2	3.10	
Roseau	90[d]	44[d]	67.2[d]	6.58	
St. Charles†	95	51	72.2	4.43	
St. Cloud	90	55	71.7	12.81	
St. Olaf	92	50	71.0	4.28	
St. Peter	91	57	72.9	7.32	
Sandy Lake Dam [1]	88*	52	69.6	13.41	
Minnesota—Cont'd.					
Shakopee [6]	96*	46	74.8	5.46	
Spring Park	......	......	......	5.32	
Tower†	94	38	67.5	9.50	
Two Harbors†	82	49	64.0	9.99	
Wabasha *[1]	99	57	73.2	8.55	
Willmar†	95	51	72.0	5.59	
Worthington	94	52	71.9	5.55	
Zumbrota [1]	94*	42	73.8	......	
Mississippi.					
Aberdeen†	108	52	82.4	1.95	
Agricultural College	100	63	81.8	4.75	
Austin†	99	57	81.6	3.95	
Batesville†	100	54	81.3	1.08	
Bay St. Louis	94	64	83.0	1.53	
Biloxi†	98	65	84.0	2.94	
Booneville†	102	57	82.4	1.70	
Briers†	94	64	81.8	4.47	
Brookhaven†	104	62	84.2	4.32	
Canton†	100	61	84.0	1.66	
Columbus *a*†	......	......	......	9.39	
Columbus *b*†	109	59	84.8	8.82	
Crystal Springs†	104	59	83.2	6.42	
Edwards	100	61	84.6	3.11	
Enterprise	102	60	81.8	5.43	
Fayette†	100	60	84.0	5.94	
Fulton†	100	58	82.0	1.50	
Greenville *a*	97	63	82.2	4.43	
Greenville *b*†	100	60	83.8	3.85	
Hattiesburg†	99	72	86.0	2.76	
Hazlehurst†	100	63	83.6	3.57	
Hernando†	101	58	82.6	0.95	
Holly Springs†	101	60	82.4	3.94	
Jackson†	100	59	83.3	4.24	
Lake†	96	59	80.8	7.12	
Leakesville†	102	61	82.2	9.78	
Logtown†	97	68	82.9	5.64	
Louisville†	102	55	81.1	2.86	
Macon†	104	59	83.1	4.73	
Magnolia†	102	57	82.3	5.76	
Mayersville	98	59	82.0	3.21	
Meridian†	100	58	82.3	3.47	
Mosspoint	97	70	84.0	2.00	
Natchez†	99	65	83.6	3.85	
Okolona†	105	58	83.6	2.21	
Pontotoc	99	59	81.4	4.58	
Port Gibson†	100	58	82.7	4.95	
Rosedale	99[c]	59[d]	82.6[c]	5.83	
Stonington *[1]	96	64	82.6	......	
Tupelo†	......	......	......	1.50	
Water Valley *†[1]	103	57	80.4	4.90	
Waynesboro *b*†	98	68	84.0	4.85	
Windham†	102	54	81.6	3.94	
Woodville†	98	60	81.1	6.35	
Yazoo City†	104	58	84.6	3.30	
Missouri.					
Akron	......	......	......	2.09	
Appleton City	101	58	80.1	1.77	
Arthur *†[3]	......	67	78.8	3.34	
Avalon	97	55	79.2	4.31	
Birchtree	97	50	77.0	2.81	
Bolckow†	......	......	......	0.77	
Boonville†	......	......	......	4.29	
Brunswick	95	56	77.8	5.63	
Carrollton†	99	58	79.4	3.05	
Conception	96	56	77.9	2.83	
Cowgill *[5]	98	56	80.4	3.80	
Darksville†	98	54	78.0	4.40	
Downing	......	......	......	3.18	
East Lynne	......	......	......	2.82	
Edgehill *[5]	98	58	76.6	2.17	
Eldon *[1]	101[c]	56	77.8[c]	1.43	
Elmira	102	49	77.8	3.43	
Emma *[3]	104	60	79.0	0.60	
Fairport	......	......	......	1.62	
Farmersville	......	......	......	4.00	
Fayette	100	58	80.2	4.02	
Fulton	......	......	......	6.21	
Gallatin *[1]	100	56	79.4	4.96	
Glasgow	98	54	79.0	3.33	
Gordonville *[3]	......	60	76.0	1.94	
Gorin	......	......	......	4.91	
Halfway	100	52	78.9	1.96	
Harrisonville†	104	55	79.4	2.72	
Hastain	104	53	81.2	1.78	
Hermann†	......	......	......	6.61	
Houston	101	49	78.1	2.01	
Houstonia	......	......	......	1.96	
Humansville	105	50	79.8	2.66	
Irena	......	......	......	3.91	
Ironton†	103	48	77.6	3.10	
Jefferson City†	104	58	80.8	3.90	
Kidder	97	52	77.0	5.00	
Lamar†	101	53	80.1	2.55	
Lamonte	......	......	......	4.12	
Lebanon	99	54	78.8	2.49	
Lexington†	103	59	80.8	2.82	
Missouri—Cont'd.					
Liberty	102	53	79.0	1.45	
McCune *†[1]	96	59	78.0	9.97	
Mansfield	......	......	......	4.20	
Marblehill	100	49	78.6	1.59	
Marshall†	101	55	79.4	2.17	
Maryville	101	53	78.0	3.77	
Mexico†	100	55	79.6	8.78	
Mineralspring	95	51	76.4	4.60	
Montreal *[1]	100	59	77.4	1.45	
Mount Vernon	101	52	80.8	3.30	
Neosho	95	49	77.8	1.85	
Nevada *[5]	100	56	81.2	4.19	
New Haven *[1]	97	60	81.6	3.73	
New Madrid	106	55	82.3	2.40	
New Palestine *†[1]	96	64	88.2	3.38	
Oakfield	100	56	79.8	3.47	
Oakmound	......	......	......	3.00	
Oakridge *[4]	......	52	75.6	2.50	
Olden†	99	50	77.6	3.56	
Oregon *a*	101	56	79.2	2.16	
Oregon *b* *[1]	101	56	78.4	2.06	
Osceola†	......	......	......	2.38	
Oto	......	......	......	2.50	
Palmyra *[5]	97	60	80.4	6.07	
Phillipsburg *†[1]	104	58	78.0	1.57	
Pickering *[3]	102	52	76.6	2.47	
Platte River *[3]	100	56	77.2	2.52	
Potosi	97	48	74.2	2.06	
Princeton	106	53	80.8	2.17	
Rhineland	98	55	78.8	5.19	
Richmond	100	59	78.8	3.15	
Rolla	......	......	......	4.15	
St. Charles	100	55	79.0	3.33	
St. James *[3]	......	60	76.8	......	
St. Joseph†	......	......	......	2.20	
St. Louis	97	53	77.7	2.07	
Sarcoxie *[3]	97	50	77.0	3.55	
Seymour *[6]	102	52	76.3	3.71	
Shelbina	......	......	......	3.80	
Sikeston	99	54	78.9	1.40	
Steffenville	......	......	......	3.50	
Stellada†	105	55	78.7	2.43	
Sublett	100	51	78.2	2.16	
Unionville†	101	52	78.7	3.24	
Vichy	102	54	79.0	3.00	
Virgil City	......	......	......	3.53	
Warrenton	99	54	78.3	3.71	
Willow Springs	101	49	77.4	2.95	
Zeitonia *[1]	101	52	77.7	0.84	
Montana.					
Augusta†	92	42	63.3	2.07	
Bigtimber	96	42	67.8	0.93	
Billings†	101	40	68.2	0.78	
Boulder	93[c]	37[c]	61.6[c]	1.32	
Bozeman†	91	40	64.0	2.59	
Bozeman Exper. Stat'n	92	38	62.0	2.09	
Butte†	92	38	59.8	1.19	
Castle	85	32	57.6	1.68	
Chinook†	99	47	69.5	1.26	
Choteau†	93[c]	37[c]	63.2[c]	1.20	
Columbia Falls	94	36	60.4	2.91	
Ekalaka	98	43	69.6	0.58	
Fort Benton	96	45	66.9	2.36	
Fort Custer†	102	48	74.6	1.60	
Fort Keogh†	103	48	73.0	0.19	
Fort Logan†	90	38	60.4	2.21	
Fort Missoula	91	40	62.6	2.14	
Glendive†	100	53	73.6	1.70	
Greatfalls†	96	45	67.4	3.24	
Hogan†	86	39	59.4	1.00	
Kalispell	89	40	60.6	1.91	
Kipp†	85	32	59.1	1.00	
Livingston†[k]	92	42	65.0	1.63	
Manhattan†	94	35	64.0	0.52	
Martinsdale†	90	38	62.0	1.74	
Marysville†	91	38	60.6	2.14	
Poplar	99	45	71.6	2.87	
Radersburg	98	......	......	2.05	
St. Pauls†	95	......	......	0.26	
Troy	95	38	62.0	1.48	
Utica†	96	38	62.8	1.74	
Virginia City†	95	36	62.4	1.43	
Wibaux†	......	......	......	1.92	
Yale†	94	40	64.6	2.71	
Nebraska.					
Agee *[1]	101	55	75.3	1.74	
Albion	102	49	74.6	2.56	
Alliance *[1]	100	49	75.7	1.73	
Ansley†	103	48	74.0	0.92	
Arapaho *[1]	102	60	81.1	1.48	
Arborville *[1]	102	50	75.8	1.12	
Arcadia	106	52	77.3	1.47	
Ashland *a*†	103	52	79.7	1.66	
Ashland *b* *[1]	103	61	82.4	1.67	
Ashton	102	51	77.1	1.30	
Auburn *†[1]	105	54	79.0	4.53	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Nebraska—Cont'd.	°	°	°	*Ins.*	*Ins.*
Aurora *[1]	104	58	83.6	1.07	
Bassett	102	47	72.3	3.50	
Beatrice †	102	52	78.8	4.76	
Beaver City †	107	51	78.1	3.13	
Benedict	......	......	......	2.24	
Benkelman	......	......	......	2.03	
Bluehill *[1]	104	58	77.6	1.94	
Brokenbow	......	......	......	1.11	
Burchard	......	......	......	5.87	
Burwell	......	......	......	1.87	
Callaway †	101	48	74.6	0.70	
Camp Clarke	104	34	70.1	3.79	
Central City	......	......	......	2.38	
Chester *[1]	100	60	78.2	7.44	
Columbus †	97	43	71.8	2.67	
Cornlea	......	......	......	3.50	
Creighton †	100	49	74.2	2.58	
Crete	99	54	77.5	3.73	
Culbertson	......	......	......	1.29	
Curtis *a*	104	53	77.5	0.60	
David City *†[1]	100	60	77.8	1.90	
Dawson	103	51	79.2	3.20	
Divide	......	......	......	0.72	
Dunning *[1]	105	58	77.0	1.55	
Eden	......	......	......	4.85	
Edgar *[1]	105	59	79.6	1.62	
Elba	......	......	......	1.46	
Ericson *†[1]	103	66	82.2	1.98	
Ewing †	......	......	......	2.76	
Fairbury †	102	53	79.6	6.26	
Fairmont †	102	52	77.5	2.06	
Filley	......	......	......	5.67	
Fort Robinson	101	40	70.7	3.60	
Franklin	112	52	79.6	2.45	
Fremont †	100	49	76.6	1.23	
Geneva †	103	50	77.4	2.39	
Genoa	100	54	75.7	4.59	
Gering †	104	38	70.8	2.76	
Gothenburg	108	48	78.0	0.70	
Grand Island *b*	104	52	76.6	2.40	
Greeley	......	......	......	0.90[e]	
Haigler	......	......	......	0.97	
Hartington †	97	51	74.0	3.78	
Harvard *[1]	102	59	78.1	1.79	
Hastings *[1]	98	58	77.1	3.89	
Hayes Center	......	......	......	2.09	
Hay Springs	104	44	71.4	3.62	
Hebron †	99	52	76.8	3.56	
Hickman	......	......	......	5.13	
Holdrege *a*	......	......	......	3.20	
Holdrege *b* *[1]	101	62	79.8	3.85	
Imperial *a* †	108	45	76.0	1.23	
Indianola (near) *[1]	100	62	77.2	0.75	
Kearney *[5]	98	60	79.6	4.01	
Kennedy	105	45	74.7	3.63	
Kimball †	100	43	71.0	6.42	
Kirkwood *[1]	103	58	74.7	3.33	
Lexington †	102	47	73.1	0.72	
Lincoln *b* †	102	53	79.2	2.79	
Lincoln *d*	103	57	78.8	2.51	
Lodgepole †	104	38	71.7	2.15	
Loup *b* *[1]	102	50	73.6	0.78	
Lynch *†[1]	99	50	74.5	3.51	
Lyons	......	......	......	1.05	
McCook *[1]	101	58	79.0	0.81	
McCool	......	......	......	1.84	
Madison *[1]	97	50	73.8	3.33	
Madrid *[5]	108	55	76.6	1.30	
Marquette	......	......	......	1.82	
Minden *a* *[1]	102	48	74.4	3.05	
Minden *b*	......	......	......	3.33	
Monroe	......	......	......	2.73	
Nebraska City *b* *[1]	99	55	79.4	2.50	
Nebraska City *c*	102	53	77.9	3.64	
Nemaha *[1]	102	59	79.9	2.25	
Nesbit	104	50	74.8	2.39	
Norfolk *a* †	96	51	75.3	3.72	
Norfolk *b*	97	53	77.0	3.73	
Norman	102	48	75.2	2.18	
North Loup †	99	49	74.9	1.19	
Oakdale †	103	50	74.2	2.98	
Odell *[5]	97	62	81.1	5.35	
O'Neill †	100	48	73.0	1.51	
Ord	104	49	75.0	1.71	
Osceola	......	......	......	1.29	
Ough †	......	......	......	1.30	
Palmer *b*	......	......	......	2.06	
Plattsmouth *a* †	......	......	......	2.56	
Ravenna *a*	101	50	75.8	1.73	
Ravenna *b* *[1]	103	60	77.4	1.29	
Redcloud *a*	......	......	......	4.32	
Redcloud *b* *[1]	100	64	80.7	3.92	
Republican *[1]	102	68	82.5	2.21	
Rulo *[1]	102	66	82.6	2.53	
St. Libory	97	52	76.6	2.60	
St. Paul	101	56	78.6	1.75	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Nebraska—Cont'd.	°	°	°	*Ins.*	*Ins.*
Salem *[1]	100	60	82.2	2.30	
Santee Agency †	104	51	77.6	2.71	
Sargent	......	......	......	2.19	
Schuyler	......	......	......	1.36	
Seneca *[1]	99	50	73.6	4.54	
Seward *[1]	99	58	77.8	2.32	
Springfield *[1]	101	54	78.4	3.79	
Springview	106	53	76.6	1.12	
Stanton *[1]	101	56	75.7	2.19	
Stockham	......	......	......	1.70	
Strang *[1]	102	62	82.2	2.99	
Stratton	......	......	......	1.45	
Stromsburg	......	......	......	1.51	
Superior *[5]	106	58	81.3	3.90	
Sutton	98	51	73.4	3.23	
Syracuse	......	......	......	1.62	
Tecumseh *b* †	103	54	79.4	2.90	
Tekamah	102	48	76.8	0.88	
Thedford *[1]	100	54	73.6	4.30	
Turlington †	103	51	77.5	2.45	
Valentine †	100	48	73.7	4.71	
Valparaiso	......	......	......	2.78	
Wakefield	100	49	75.1	2.89	
Wallace *[1]	106	52	76.6	0.86	
Weeping Water *[1]	102	48	75.4	1.87	
Westpoint †	100	51	76.4	2.24	
Whitman	......	......	......	0.35	
Wilber *[1]	96	66	82.3	5.11	
Willard	......	......	......	2.42	
Wilsonville *[1]	104	62	80.6	1.05	
Wisner *[5]	101[d]	60[d]	79.2[d]	1.39	
Woodlawn	......	......	......	3.00	
York *[1]	106	61	80.5	1.60	
Nevada.					
Austin	91	40	66.8	0.39	
Battle Mountain *[1]	99	45	68.6	0.00	
Beowawe *[1]	98	50	71.3	0.40	
Candelaria [f]	97	46	72.4	0.20	
Carlin *[1]	106	43	71.2	T.	
Carson City	92	35	65.2	0.27	
Cloverdale *[1]	91	59	72.9	0.06	
Cranes Ranch	......	......	......	0.35	
Downeyville	107	46	77.6	0.58	
Elko *[8]	102	40	61.7	0.00	
Elko (near)	102	35	66.5	......	
Ely	94	30	63.4	0.80	
Fenelon *[1]	97	41	67.4	T.	
Genoa	100	38	71.8	0.00	
Golconda *[1]	98	44	69.4	0.00	
Gold Creek *[1]	94	42	64.2	0.81	
Halleck *[1]	102	51	69.3	0.26	
Hamilton	96	25	61.6	0.60	
Hawthorne *a* *[8]	95	59	76.7	0.00	
Hawthorne *b*	97	47	73.0	0.80	
Hot Springs *[1]	102	62	80.6	T.	
Humboldt *[1]	95	56	73.5	0.00	
Keysers Springs	......	......	......	0.40	
Lewers Ranch	92	30	65.4	T.	
Los Vegas [d]	100	55	77.6	T.	
Lovelock *[1]	103	66	81.4	0.00	
McGill [1]	100	30	63.2	0.18	
Midas	92	47	68.8	0.29	
Mill City *[1]	105	50	71.9	0.00	
Monitor Mill	96	30[e]	63.7	0.19	
Osceola	96	44	72.4	0.27	
Palisade *[8]	97	60	77.0	0.00	
Palmetto	94	35	66.0	1.41	
Reno *[8]	105	45	73.2	0.00	
Reno State University	93	39	67.3	T.	
Ruby Valley	......	......	......	0.54	
St. Thomas	116	60	89.8	T.	
San Antonio	100	42	71.5	0.18	
Silver Peak	101	48	74.9	0.95	
Tecoma *[1]	102	50	69.1	0.00	
Toano *[1]	99	50	70.2	0.59	
Tuscarora	94	32	62.0	0.37	
Tybo	100	40	69.8	0.80	
Verdi *[1]	102	48	64.0	0.00	
Wadsworth *[1]	100	60	76.0	0.00	
Wells	98	28	66.2	0.31	
New Hampshire.					
Concord	98	42	70.6	8.56	
Durham	96	47	69.7	6.98	
Grafton †	96[f]	41[f]	69.2[f]	7.30	
Hanover	91	52	72.3	7.97	
Keene	95	47	70.7	10.19	
Lancaster	95	43	71.0	7.38	
Nashua	97	47	71.9	4.45	
Newton	95	43	70.4	4.22	
North Conway	95	45	70.1	7.89	
Peterboro	94	45	70.7	9.28	
Plymouth	102	44	72.6	6.77	
Sanbornton †	92	45	69.6	8.55	
Stratford	100	42	72.6	10.00	
Warner	......	......	......	8.58	
West Milan	97	40	68.8	5.56	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
New Jersey.	°	°	°	*Ins.*	*Ins.*
Asbury Park	89	61	71.8	8.92	
Barnegat	90	64	75.6	10.03	
Bayonne	96	62	75.5	16.96	
Beachhaven	89	64	73.6	8.76	
Belvidere	97	58	73.8	10.92	
Beverly †	96	58	75.7	11.11	
Billingsport *[1]	92	67	75.4	9.27	
Blairstown	96	58	73.9	9.94	
Boonton	100	56	74.0	11.63	
Bridgeton	94	65	77.9	11.93	
Camden	91	61	74.6	6.11	
Cape May C. H. †	86	62	73.9	9.98	
Charlotteburg	93	50	68.0	13.34	
Chester	93	57	72.0	12.83	
Clayton	95	60	75.2	12.22	
College Farm †	96	60	75.0	12.84	
Deckertown	96	55	72.4	9.27	
Dover	100	56	73.4	13.27	
Egg Harbor City	92	60	74.2	10.22	
Elizabeth †	98	61	75.6	20.80	
Englewood	93	57	73.6	17.87	
Franklin Furnace	94	52	72.2	9.58	
Freehold	90	60	73.5	13.60	
Friesburg	......	......	......	6.65	
Gillette	96	54	72.1	10.43	
Hammonton	......	......	......	10.94	
Hanover	95	59	73.3	8.82	
Hightstown	95	60	75.2	12.19	
Imlaystown	98	61	76.5	10.18	
Junction	......	......	......	8.72	
Lambertville	96	59	75.2	10.53	
Moorestown	96	61	76.0	11.35	
Newark *b* †	96	60	75.0	19.09	
New Brunswick *a*	102	60	76.2	13.23	
New Brunswick *b*	94	58	72.8	13.05	
Newton	97	54	71.4	10.87	
Ocean City	88	61	73.0	6.70	
Oceanic	89	62	73.1	12.88	
Paterson	97	60	74.8	9.98	
Perth Amboy	94	60	74.3	16.16	
Plainfield	95	59	74.3	13.92	
Rancocas	......	......	......	12.21	
Readington *[6]	96[e]	64[e]	79.5[e]	......	
Rivervale	100	56	72.9	8.91	
Roseland	98	56	73.2	11.51	
Sergeantsville	95	54	73.4	9.83	
Somerville	99	58	75.6	11.08	
South Orange	94	59	74.0	15.80	
Staffordville	......	......	......	12.19	
Toms River	92	59	74.2	12.03	
Trenton	96	65	77.8	9.87	
Vineland	98	59	75.6	12.56	
Woodbine	89	57	73.6	7.07	
New Mexico.					
Albert	99	52	76.6	1.56	
Albuquerque †	94	50	75.4	0.31	
Alma	94	52	73.4	3.04	
Angus V. V. Ranch	84	43	65.4	5.15	
Aztec †	94	39	69.8	0.78	
Bernalillo †	97	56	75.8	0.69	
Bluewater †	101	34	70.7	0.75	
Buckmans	85	27	60.4	3.30	
Clayton	101	50	74.1	1.26	
Deming *[8]	104	65	80.0	2.89	
East Lasvegas †	86	43	67.3	1.18	
Eddy	104	55	81.2	0.50	
Engle †	100	57	77.8	3.79	
Espanola †	95	47	71.7	0.92	
Fort Bayard	96	51	71.5	3.38	
Fort Union	88	47	66.6	2.36	
Fort Wingate	94	47	69.4	0.91	
Galisteo †	94	46	70.8	1.08	
Gallinas Spring †	102	54	73.8	3.05	
Gila	101	55	77.9	1.73	
Hillsboro †	95	53	76.7	3.44	
Las Cruces †	96	51	76.1	2.25	
Lordsburg *[8]	96	70	80.7	3.95	
Los Lunas †	98	49	75.0	0.80	
Lower Penasco	90	52	71.6	5.60	
Monero †	88	29	62.2	2.86	
Ocate †	87	36	65.8	2.29	
Olio	99	38	72.9	0.39	
Puerto de Luna †	101	51	78.4	1.62	
Raton †	93	30	68.2	0.10	
Rincon †	99	56	79.6	1.95	
Roswell †	98	54	77.5	2.78	
San Marcial †	95	52	75.2	1.18	
Shattucks Ranch	94	39	68.6	1.95	
Springer †	95	44	69.9	2.71	
Valley Ranch	99	34	66.6	1.12	
White Oaks †	92	49	67.6	1.78	
Winsors Ranch	84	24	57.2	1.98	
New York.					
Adams	......	......	......	8.22	
Addison	95	51	71.5	4.52	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
New York—Cont'd.	°	°	°	*Ins.*	*Ins.*
Akron				4.03	
Angelica †	95	50	70.7	5.14	
Appleton	98	56	72.5	5.08	
Arcade	95	53	70.5	8.35	
Atlanta				7.47	
Avon	102	55	74.3	4.08	
Baldwinsville	98	55	74.4	5.95	
Bedford	92	57	71.6	11.42	
Big Sandy *[10]	92	56	72.2		
Binghamton †	96	54	71.8	2.54	
Bolivar	95	48	69.3	6.36	
Boyds Corners				12.51	
Brentwood	92	55	72.0	10.00	
Brooklyn	93	61	74.4	11.06	
Canajoharie	99	53	75.1	6.48	
Canton	98	54	72.8	7.58	
Carmel	93	56	73.3	16.64	
Catskill	95	58	73.3	9.82	
Cedar Hill				7.46	
Charlotte *[10]	94	50	68.6		
Chenango Forks				4.85	
Cherry Creek				6.23	
Cooperstown †	91	53	70.5	4.86	
Cortland	94	50	70.8	4.46	
De Kalb Junction				4.84	
Dryden	96	52	71.8	4.30	
Eagle Mills				4.05	
Easton				7.09	
Elizabethtown	94	44	67.8	13.00	
Elmira	98	55	74.4	3.23	
Fleming	95	57	73.4	3.86	
Fort Niagara †	95	58	74.0	7.01	
Franklinville	96	51	70.4	5.88	
Friendship	97	47	69.5	4.47	
Garrattsville	90	52	69.0	6.21	
Glens Falls	94	52	73.1	8.82	
Gloversville	93	52	70.7	9.80	
Haskinsville				5.56	
Honeymead Brook	92	56	71.6	14.55	
Humphrey †	90	52	69.5	7.77	
Ithaca	94	56	72.4	3.25	
Jamestown	95	53	71.8	5.93	
Kings Station				8.83	
Lake George	92	53	70.9	8.83	
Little Falls	94	53	71.2	4.68	
Lockport	99	57	74.6	3.30	
Lowville	95	50	70.6	2.96	
Lyndonville				4.63	
Lyons	96	58	73.4	5.04	
Madison Barracks †	99	53	74.2	2.55	
Manhatton Beach	90	60	69.8	8.51	
Middletown	96	53	73.2	9.14	
Mohonk Lake	89	53	70.6	14.71	
Mount Morris				2.20	
Newark Valley				4.43	
New Lisbon	94	48	68.8	5.58	
Niagara Falls				6.73	
North Hammond †	100	56	73.4	4.33	
North Lake	91	50	67.6	4.15	
Number Four †	90	49	68.0	6.46	
Ogdensburg	95	57	72.2	4.62	
Oneonta	97	51	72.4	6.61	
Oxford	98	48	71.0	8.04	
Palermo †	95	49	71.6	4.22	
Perry City	97	51	71.4	3.55	
Phœnix				8.56	
Pine City				5.10	
Pittsford	98	57	72.7	6.37	
Plattsburg Barracks †	93	52	70.8	7.19	
Port Jervis	93	55	72.1	9.23	
Poughkeepsie	96	55	73.0	9.37	
Primrose	96	58	74.1	11.12	
Ridgeway	96	58	73.2	5.51	
Rome	97	52	72.0	4.92	
Romulus	97	57	74.0	4.14	
Rose				3.84	
St. Johnsville	91	53	70.8	4.67	
Saranac Lake	95	51	70.0	8.55	
Schenevus				5.35	
Scottsville				6.58	
Setauket †	88	60	72.4	18.18	
Sherwood				4.36	
Skaneateles				4.92	
South Canisteo	95	48	69.2	5.62	
Southeast Reservoir				11.15	
South Kortright †	98	43	65.6	5.56	
Straits Corners	97	49	72.0	4.04	
Tyrone				2.91	
Wappingers Falls	99	58	78.4	11.84	
Warwick				11.10	
Watkins	96	53	73.2	3.19	
Waverly †	98	46	72.6	4.50	
Wedgwood	98	53	72.8	3.43	
Westfield	94	57	73.7	8.21	
Westpoint †	96	58	74.5	13.05	
Willetspoint	92	60	73.5	9.75	
North Carolina.	°	°	°	*Ins.*	*Ins.*
Abshers	99	51	75.2	3.93	
Asheville †	93	50	71.8	4.40	
Beaufort †	94	67	80.2	4.60	
Biltmore †	93	48	72.7	3.70	
Bryson City †				5.29	
Chapelhill †	101	60	78.2	1.43	
Edenton	95	63	80.1	3.05	
Experimental Farm	97	65	79.1	5.65	
Fairbluff †				7.94	
Fayetteville †	99	59	79.0	11.11	
Flatrock	90	48	71.5	4.22	
Goldsboro †	99	63	80.2	9.52	
Greensboro †	101	58	78.6	5.35	
Greenville	95			3.12	
Henderson †	98	62	78.2	6.82	
Highlands	84	45	66.0	9.44	
Horse Cove	91	55	72.6	9.25	
Jacksonville	99	59	79.7	4.68	
Lenoir *†[1]	92	56	74.3	2.69	
Linville †	82	45	66.2	7.38	
Littleton †	97	58	77.6	3.94	
Louisburg †	99	60	79.4	4.11	
Lumberton †	101	64	81.6	8.03	
Lynn *†[2]	91		75.6	3.54	
Mana				2.39	
Marion	94	54	74.4	6.98	
Moncure †	97	58	77.7	3.23	
Monroe †	94	57	77.3	6.73	
Morganton	97	62	77.6	3.70	
Mountairy †	95	52	75.0	5.06	
Mount Pleasant	98	58	77.9	6.25	
Murphy †				10.39	
Newbern †	95	68	80.7	2.55	
Oakridge †	97	57	76.8	5.18	
Pantego *[3]		70	75.8	7.58	
Pittsboro †	95	59	76.8	6.62	
Rockingham †	102	60	80.4	4.98	
Roxboro †	96	58	75.9	4.10	
Salem †	98	56	77.5	4.71	
Salisbury †	101	60	79.8	7.78	
Saxon †	103	53	77.6	3.39	
Selma	99	60	79.4	6.45	
Settle	99	58	78.2	5.01	
Skyuka				9.12	
Sloan †	99	58	78.8	2.07	
Soapstone Mount †	98	54	76.4	6.88	
Southern Pines *a* †	102	60	79.4	7.96	
Southern Pines *b*	101	65	80.0	8.39	
Southport †	100	64	80.4	3.62	
Springhope *[1]	96	67	78.2	6.75	
Tarboro	99	57	78.8	6.69	
Waynesville †	89	47	69.7	4.89	
Weldon †	99	60	79.2	4.20	
Willeyton	95	59	78.4	4.64	
North Dakota.					
Amenia	91	50	69.5	8.94	
Ashley †	96	42	68.3	3.96	
Bordulac	91	38	65.9	8.55	
Buxton	89	48	68.2	5.99	
Churchs Ferry	97	49	69.2	2.84	
Coalharbor †	99	48	70.2	2.17	
Devils Lake †	96	49	68.2	7.23	
Dunseith	106	45	72.4	2.70	
Ellendale	104	50	72.2	4.07	
Falconer	104	43	70.4	3.25	
Fargo †	89	49	69.4	8.24	
Forman †[k]	98	38	65.6	3.48	
Fort Yates †	101	46	70.4	2.35	
Gallatin †	93	40	68.7	4.00	
Glenullin	102	40	69.6	0.33	
Goetz	97	43	68.8		
Grafton †	91	48	67.6	6.42	
Grand Rapids †	93	43	67.0	4.98	
Hamilton	98	47	68.2	8.38	
Jamestown †	90	48	67.8	4.56	
Langdon †	91	45	65.8	5.55	
Larimore †	89	47	66.8	6.11	
McKinney	95	42	66.6	2.40	
Mayville	89[e]	50[e]	69.0[e]	5.74	
Medora †	109	43	72.3	2.34	
Milton †	95	45	67.0	6.95	
Minnewaukon	96	47	67.2	6.80	
Minot †	100	44	70.0	1.87	
Minto †	93	45	68.4	4.78	
Napoleon †	97	45	67.7	4.90	
New England City	100	42	69.8	1.60	
Oakdale †	93	47	68.3	1.42	
Power †	91	53	72.0	7.62	
St. John †	90	48	66.8	2.92	
Sheyenne	95	46	67.8	6.52	
Steele †	96	45	67.4	3.95	
Towner †	95	43	67.9	1.85	
University				6.44	
Valley City †	85	43	65.3	5.36	
Wahpeton †	100	49	74.5	8.58	
Whites Ranch	106	42	73.0	0.78	
North Dakota—Cont'd.	°	°	°	*Ins.*	*Ins.*
Wildrice †[2]			68.8	8.83	
Willow City *	96	41	68.4	2.77	
Woodbridge †	92	42	65.3	4.41	
Ohio.					
Akron	98	54	74.8	5.06	
Annapolis	103	50	74.0	4.11	
Ashland	94	52	72.6	3.62	
Ashtabula	94	55	73.0	10.69	
Atwater				4.60	
Auburn				7.65	
Bangorville	98	52	74.4	4.87	
Bellefontaine	100	53	76.8	6.29	
Bement				5.92	
Benton Ridge	104	52	76.3	3.99	
Bethany	105	49	78.2	6.85	
Bigprairie	97	51	74.0	4.85	
Binola				4.70	
Bissells	102	55	74.2	6.01	
Bloomingburg	99	53	75.4	5.99	
Bowling Green	99	53	74.8	2.31	
Bucyrus	105	50	76.8	5.90	
Cambridge	97	51	73.5	6.12	
Camp Dennison	101	57	78.5	5.70	
Canal Dover	100	53	75.4	6.91	
Canfield				10.55	
Canton †	96	54	74.5	5.70	
Carrollton	102			5.36	
Cedarville				4.43	
Celina				2.13	
Cherryfork	104	50	77.9	4.81	
Chillicothe †				5.52	
Circleville	98	56	76.3	6.06	
Clarksville	100	53	76.6	4.94	
Cleveland *a*	95	56	73.4	3.53	
Cleveland *b*	99	52	75.0	2.63	
Clifton	103	51	76.8	3.12	
Coalton	102	51	76.8	4.95	
Colebrook	99	57	75.3	7.14	
Dayton *a*	104	54	78.5	3.49	
Dayton *b* †				8.71	
Defiance	98	51	73.6	3.61	
Delaware	101	53	77.0	4.04	
Demos	98	53	74.2	3.40	
Dupont	97	53	76.0	2.68	
Elyria	101	54	74.5	4.86	
Fairport Harbor *[10]	92	60	75.2		
Fayetteville	99	54	76.4	10.42	
Findlay	102	52	77.4	3.08	
Frankfort	99	55	73.6	4.45	
Garrettsville †	98	49	72.2	6.34	
Granville	97	53	75.4	5.37	
Gratiot	96	54	74.8	5.09	
Greenfield	100[d]	57[d]	78.0[d]	4.96	
Greenhill	102	50	74.2	6.12	
Greenville	93	56	74.6	5.39	
Hackney				5.14	
Hanging Rock	100	54	77.0	5.73	
Hedges	100	52	75.0	0.82	
Hillhouse	100	49	72.4	7.64	
Hillsboro †	105	55	77.6	5.00	
Hiram	96	53	73.0	6.51	
Hudson	98	49	75.2	4.45	
Jacksonboro	101	49	78.0	3.40	
Kenton †	99	52	76.0	3.54	
Killbuck	100	47	73.4	7.17	
Lancaster	97	56	75.8	5.94	
Leipsic	101	52	75.5	4.87	
Levering	99	44	71.1	3.44	
Logan	103			5.05	
Lordstown	97	54	73.4	8.37	
McArthur	97	55	78.0	6.32	
McConnelsville †	97	55	75.8	5.20	
Mansfield †				3.91	
Marietta *b*	95	58	76.4	7.03	
Marion	100	54	75.6	7.28	
Medina	99	50	74.4	4.04	
Milfordton	97	50	74.2	4.82	
Milligan	100	58	78.6	9.44	
Millport	96	50	72.0	4.77	
Montpelier	100	54	75.0	2.46	
Napoleon	104	51	75.9	3.84	
Neapolis				2.48	
New Alexandria	94	56	74.2	5.61	
New Berlin	100	50	73.8	7.55	
New Bremen	100	52	76.4	4.50	
New Comerstown	100	54	74.8	5.15	
New Holland	104	55	77.3	3.80	
New Moscow				7.40	
New Paris	104	54	78.2	2.01	
New Waterford	93	50	72.3	8.88	
North Lewisburg	100	52	76.0	5.50	
North Royalton	100	51	74.4	3.08	
Norwalk	100	54	74.8	5.28	
Oberlin	101	53	74.4	2.12	
Ohio State University	98	54	75.7	2.73	
Orangeville	98	49	72.8	8.07	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Ohio—Cont'd	°	°	°	*Ins.*	*Ins.*
Ottawa	99	55	76.1	2.25	
Pataskala †	101	52	76.2	4.19	
Philo	101	53	76.3	7.00	
Plattsburg	101	52	75.6	5.20	
Pomeroy	100	56	77.1	3.54	
Portsmouth *a* †				4.86	
Portsmouth *b*	106	58	80.0	4.86	
Richwood				5.10	
Ridgeville Corners	98	52	74.2	2.43	
Ripley	98	54	77.1	4.73	
Rittman	97	47	72.6	4.79	
Rockyridge	104	55	76.4	3.08	
Rosewood †	97	53	74.4	3.28	
Shenandoah	100	49	74.1	2.90	
Sidney *b*	101	56	78.0	2.63	
Sinking Spring †	97	51	76.1	5.02	
Somerset †	96	59	77.7	4.81	
Springboro				3.30	
Spring Valley	101	54	76.8	5.44	
Sylvania	99	50	74.1	2.29	
Tiffin †	98	55	75.6	1.97	
Upper Sandusky	98	54	75.0	3.40	
Urbana	94	54	75.2	4.78	
Vanceburg	99	55	76.1	3.89	
Van Wert	98	54	75.4	3.54	
Vermilion	98	56	73.8	4.73	
Vickery	103	55	76.7	2.99	
Walnut				6.05	
Warren	100	52	74.5	8.23	
Wauseon	102	53	75.8	3.67	
Waverly	101	56	78.0	5.82	
Waynesville				3.77	
Wellington	102	53	75.6	2.99	
Westerville	92[d]	56[d]	73.8[d]	5.81	
Willoughby				3.33	
Wooster *b* †	96	50	73.2	3.89	
Youngstown	99	51	72.2	7.48	
Zanesville †				6.40	
Oklahoma.					
Alva	108	55	84.6	0.90	
Anadarko †	104	51	83.2	2.19	
Arapaho †	107	54	82.2	1.74	
Beaver				5.12	
Burnett †	102	48	80.3	2.42	
Clifton †	102	54	81.6	3.63	
Edmond				2.94	
Fort Reno †	107	56	81.0	0.66	
Fort Sill	106	55	81.8	1.95	
Hennessey	108	60[c]	85.2	0.88	
Jefferson	105	54	83.2	1.15	
Keokuk Falls	103	55[f]	81.7[f]	1.80	
Kingfisher	110	55	83.9	0.48	
Mangum †	106	55	80.8	2.28	
Norman †	106	55	83.6	2.34	
Ponca				4.15	
Prudence †	106	56	80.1	1.59	
Sac and Fox Agency †	104	50	80.9	2.70	
Stillwater †	106	51	81.2	2.63	
Waukomis	107	54	83.6	2.27	
Winnview †	110	56	84.0	1.54	
Woodward	109	56	83.8	0.52	
Oregon.					
Albany *a*	86	46	65.4	0.97	
Arlington	102	50	71.8	T.	
Ashland *b*	96	40	66.6	T.	
Aurora *[8]	94	54	69.7	0.93	
Aurora (near)	86	41	61.9	0.83	
Bandon	70	45	58.8	0.32	
Bay City †	79	40	58.4	3.69	
Brownsville *[8]	88	60	70.3	0.55	
Burns	92	30	59.6	0.75	
Burns (near)	95	36	63.3	0.00	
Canyon City	98	39	67.4	0.23	
Cascade Locks	94	48	66.6	0.62	
Corvallis *a*	89	42	62.9	0.09	
Dayville †	100	40	65.3	T.	
Falls City				0.72	
Fife †	92[e]	31[e]	60.2[e]	0.00	
Fort Klamath	87[d]	30[d]	57.3[d]	0.03	
Gardiner	75	47	59.7	0.82	
Glenora	92	38	60.2	1.84	
Government Camp	86	30	51.4	4.14	
Grants Pass *a* †	97	42	66.9	0.00	
Heppner	100[b]	41[f]	66.4[e]	0.38	
Hood River (near)	91	47	65.0	0.18	
Irvington				0.49	
Jacksonville	94	42	67.0	0.00	
Joseph	89	33	58.2	0.60	
Junction City *[8]	90	50	65.9	0.43	
Lafayette *[8]	95	51	68.9	0.71	
Lakeview †	91	33	62.8	0.10	
Langlois	83	45	62.4	0.77	
Lonerock	96	30	58.1	0.60	
McMinnville	93	40	63.8	0.42	
Merlin *[8]	100	54	70.6	0.00	
Monmouth *[8]	91	58	67.7	0.40	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Oregon—Cont'd.	°	°	°	*Ins.*	*Ins.*
Mount Angel †	90	46	65.0	0.24	
Nehalem				2.22	
Newbridge	100	33	65.2	0.33	
Newport	73	42	57.2	1.01	
Pendleton	107	39	68.1	0.68	
Prineville	93	34	62.3	0.00	
Riddles *[8]	94	48	66.0	0.00	
Riverside	101	34	66.8	0.35	
Salem *b* †	87	43	63.4	0.64	
Sheridan *[8]	91	56	69.4	0.31	
Silver Lake	92	28	59.5	0.07	
Silverton *[8]	92	58	66.4	1.08	
Siskiyou *[8]	90	45	64.6	0.00	
Sparta	92	34	62.7	0.04	
Springfield *[8]	87	55	67.0	0.35	
Stafford	89[c]	44	63.4	0.95	
The Dalles †	98	48	69.4	0.24	
Umatilla				0.45	
Vale	102	38	67.0	0.09	
Vernonia	97	37	60.3	0.76	
West Fork *[8]	98	46	63.8	0.19	
Weston	99	43	65.4	0.76	
Williams	93	40	64.7	0.00	
Pennsylvania.					
Altoona	94	57	74.9	3.22	
Aqueduct	103	57	78.0	3.78	
Beaver Dam				4.86	
Bethlehem				4.84	
Blooming Grove	97	52	70.6	9.39	
Brookville †				9.97	
Browers Lock				7.13	
Cameron				6.81	
Canonsburg	98	57	75.8	2.10	
Carlisle	96	57	76.0	4.42	
Cassandra	91	51	70.4	3.44	
Cedarrun				3.96	
Centerhall †	88	56	70.6	4.96	
Chambersburg †	95	53	74.0	4.32	
Coatesville	95	57	75.7	6.47	
Confluence †	99	53	74.4	6.46	
Coopersburg	93	60	73.8	6.48	
Davis Island Dam †				6.31	
Derry Station	103	52	75.5	4.99	
Doylestown				8.11	
Driftwood				9.29	
Dubois				6.57	
Duncannon				4.66	
Dunmore	102	54	73.4	4.17	
Dushore	95	46	71.2	3.63	
Dyberry	94	50	70.2	6.03	
East Bloomsburg				2.74	
East Mauch Chunk	100	54	73.6	8.33	
Easton	94	60	74.4	8.04	
Edinboro *[1]	99	56	72.8		
Ellwood Junction †				10.94	
Emporium	95	55	72.6	5.28	
Everett	89	53	71.6	5.02	
Farrandsville				5.70	
Forks of Neshaminy *[1]	91	64	75.0	12.42	
Franklin	100	53	73.5	5.74	
Frederick				9.97	
Freeport †				8.08	
Girardville				5.58	
Grampian	94	56	72.7	7.02	
Greensboro †	105	60	79.4	4.42	
Greenville	95	49	70.8	8.16	
Hallstead †	96	54	72.2	3.89	
Hamburg	101	58	75.8	6.99	
Hollidaysburg	97	50	73.5	4.07	
Honesdale	100	55	74.4	5.84	
Huntingdon *a* †	95	50	73.8	3.13	
Huntingdon *b*				3.57	
Irwin				5.39	
Johnstown †	99	53	74.3	5.97	
Karthaus				5.18	
Keating				4.57	
Kennett Square	93	58	74.9	10.16	
Lansdale				7.17	
Lawrenceville				4.27	
Lebanon	98	56	75.0	5.89	
Leroy †	95	54	71.9	3.95	
Lewisburg	96	58	74.8	4.72	
Lock Haven *a* †	98	41	74.4	5.65	
Lock Haven *b*				5.14	
Lock No. 4 †				3.72	
Lycippus	98	56	76.0	2.82	
Mifflin				2.95	
Oil City †				7.97	
Ottsville				6.82	
Parker †				7.23	
Philadelphia *b*	94	62	76.5	10.25	
Point Pleasant				8.76	
Pottstown	96	60	76.2	6.27	
Quakertown [f]	96	54	74.3	8.06	
Reading[2]			75.6	5.77	
Renovo *a*				5.73	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Pennsylvania—Cont'd.	°	°	°	*Ins.*	*Ins.*
Renovo *b*	95	55	73.6	4.80	
Ridgway †				6.70	
Saegerstown	99	46	71.1	14.51	
St. Marys	96	50	70.2	5.91	
Salem Corners	91	54	70.7	6.64	
Scranton	96	51	72.4	5.00	
Seisholtzville				5.61	
Selinsgrove	95	54	75.6	5.08	
Shawmont				11.45	
Shinglehouse	98	48	71.3	5.12	
Sinnamahoning				6.91	
Smiths Corners				10.22	
Somerset	93	52	70.3	4.89	
South Bethlehem	96	59	76.3		
South Eaton	91	57	72.0	3.38	
State College	92	54	71.5	5.69	
Sunbury				2.88	
Swarthmore	94	62	76.4	10.43	
Swiftwater	89	55	69.5	13.10	
Towanda	96	51	72.6	4.81	
Uniontown	95	54	73.5	6.83	
Warren *a* †	95	51	72.0	6.15	
Wellsboro †	95	52	71.0	5.46	
West Chester	92	59	74.8	9.91	
West Newton †				4.51	
White Haven	94	53	70.8	6.49	
Wilkesbarre †	99	54	74.8	3.76	
Williamsport	93	57	73.0	4.77	
York †	95	56	75.7	3.69	
Rhode Island.					
Bristol	81	55	70.4	5.33	
Kingston	87	54	70.6	6.35	
South Carolina.					
Allendale †	101	60	81.6	5.05	
Anderson †				6.06	
Batesburg †	107	62	81.8	8.16	
Blackville †	102	60	81.8	3.79	
Camden †				5.94	
Central †	101	56	79.1		
Cheraw *a* †	104	58	81.2	6.08	
Cheraw *b* †				6.64	
Conway †				3.66	
Darlington (near)				8.05	
Edisto †				6.82	
Effingham †				4.91	
Florence †	99	59	80.0	6.45	
Gaffney †				1.67	
Georgetown †	96	63	81.9	4.90	
Gillisonville †	103	60	81.4	7.99	
Greenville †	97	55	76.8	5.75	
Greenwood	100	61	80.4	5.16	
Holland	102			5.82	
Kingstree *a* †	101	62	82.5	4.69	
Kingstree *b*				4.71	
Little Mountain	102	62	80.6	3.44	
Longshore †	98	60	78.6	4.78	
Mount Carmel †				4.86	
Pinopolis *[1]	93	67	77.7	8.43	
Port Royal †	101	70	83.2	5.65	
St. George †	99	64	80.5	8.81	
St. Matthews †	101	63	81.2	6.15	
St. Stephens †				9.81	
Santuck †	99	58	79.0	3.60	
Shaws Fork *[1]	97	61	80.0	3.53	
Smiths Mills †				4.69	
Society Hill †	96	61	78.4	6.20	
Spartanburg	99	55	79.0	2.99	
Statesburg †	100	64	80.2	5.82	
Trenton	99	63	80.9	6.97	
Trial †	96	58	78.8	7.29	
Walhalla	98	54	76.3	3.33	
Winnsboro	98	58	79.0	3.38	
Yemassee †	104	60	82.0	7.57	
Yorkville	99	62	80.2	6.71	
South Dakota.					
Aberdeen †	98	49	71.2	4.81	
Alexandria †	100	47	73.8	4.94	
Armour †	101	48	73.8	3.62	
Ashcroft †	107	35	70.2	0.73	
Brookings † [c]	95	46	71.2	4.32	
Canton	98	49	74.4	4.23	
Castlewood †	98	41	71.6	7.27	
Centerville				3.41	
Chamberlain †	105	50	76.4	2.44	
Cross †	94	38	65.0	1.01	
Doland	102	41	73.6	2.70	
Edgemont				1.81	
Flandreau	98	48	71.0	5.66	
Forestburg †	100	48	73.8	3.98	
Forest City				3.00	
Fort Meade †	101	49	71.4	2.05	
Goudyville	102	41[d]	70.9[b]	2.22	
Highmore	105	51	75.4	3.75	
Hitchcock				2.36	
Hotch City †	104	44	74.4	3.27	
Hot Springs	95	48	73.2	1.16	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
South Dakota—Cont'd.	°	°	°	*Ins.*	*Ins.*
Howard †	98	48	73.0	5.36	
Kimball †	104	46	74.4	2.26	
Leslie †	104	46	76.7	0.53	
Mellette †	98	47	73.0	3.41	
Menno †	103	49	76.6	3.87	
Millbank	95	50	71.4	3.92	
Mitchell †	101	46	73.3	4.65	
Oelrichs †	106	39	74.0	2.40	
Parker †	102	45	74.0	3.34	
Parkston †[c]	99	45	72.0	3.76	
Plankinton †	105	48	75.2	4.18	
Rosebud	100	38	73.0	2.50	
Silver City	...	...	...	1.42	
Sioux Falls †	100	46	73.6	4.45	
Spearfish †	90	51	70.7	0.46	
Tyndall †	101	50	75.4	1.42	
Watertown	94	44	69.0	5.72	
Wentworth †	97	47	72.4	6.34	
Wessington Springs	101	50	73.7	3.83	
Tennessee.					
Andersonville	96	57	75.9	5.39	
Arlington †	100	58	81.6	5.67	
Arthur †	...	...	...	5.69	
Ashwood *†[1]	100	64	80.1	3.00	
Benton (near) †	100	52	76.8	5.53	
Bluff City †	...	...	...	5.44	
Bolivar †	100	53	80.4	0.68	
Bristol †	94	50	72.9	6.13	
Brownsville †	103	58	83.5	0.40	
Byrdstown	94	52	75.4	7.83	
Cagle	95	53	74.2	7.72	
Carthage †	...	...	...	6.35	
Center Point †	...	...	...	1.01	
Clinton †	...	...	...	5.39	
Covington	103	65	83.8	2.85	
Decatur †	98	54	77.0	6.05	
Dyersburg	101	58	82.4	2.11	
Elizabethton †	98	52	75.6	6.62	
Elk Valley	94	53	75.8	5.60	
Erasmus	91	46	71.5	10.64	
Fairmount *[1]	90[d]	61[e]	72.4[d]	8.60	
Florence †	100	58	78.3	6.66	
Franklin	100	56	78.6	5.02	
Grace	...	...	...	9.21	
Greeneville †	93	53	74.1	3.54	
Harriman	96	52	76.2	10.10	
Hickory Withe	100	59	82.2	3.26	
Hohenwald †	101	48	77.1	4.20	
Jackson †	99	55	80.8	1.72	
Johnsonville †	100	52	80.0	3.54	
Jonesboro *[1]	89	61	73.0	5.72	
Kingston †	...	...	...	5.93	
Liberty †	97	55	78.1	4.21	
Loudon †	...	...	...	7.60	
Lynnville †	98	53	78.0	7.35	
McKenzie †	102	57	81.2	3.26	
McMinnville †	97	55	76.6	9.10	
Milan †	104	55	82.6	1.80	
Molino †	103	58	79.4	4.66	
New Market *[1]	92	60	75.0	8.52	
Newport †	94	55	76.6	3.50	
Nunnelly *[1]	98	53	77.7	2.38	
Oak Hill *[1]	96	52	75.6	13.21	
Palmetto †	100	58	78.4	7.36	
Pope	100	53	79.3	2.42	
Riddleton †	97	55	77.2	7.14	
Rogersville †	91	53	73.6	4.31	
Rugby	94	49	73.2	6.55	
St. Joseph †	105	50	79.4	3.14	
Savannah	105	53	81.2	3.46	
Sewanee †	91	53	73.6	7.21	
Silver Lake	...	...	...	6.98	
Springdale *[1]	92	60	77.4	5.12	
Springfield *[1]	98	60	78.8	3.14	
Sylvia	100	54	79.2	5.14	
Tellico Plains †	101	55	77.0	8.71	
Tracy City	97	49	73.2	8.45	
Trenton	99	53	79.2	1.56	
Tullahoma †	98	51	75.2	4.20	
Union City †	100	54	80.4	2.23	
Waynesboro	102	51	78.4	3.26	
Texas.					
Arthur City †	...	...	...	2.98	
Austin *b* *[5]	103	65	85.2	...	
Ballinger †	101	57	82.3	3.28	
Beeville †	106	66	87.0	0.15	
Blanco †	103	68	88.3	T.	
Brazoria †	100	69	84.0	0.27	
Bremond *[1]	102	77	88.3	0.08	
Brenham †	106	69	87.4	2.94	
Brighton †	98	67	83.0	T.	
Brownwood	108	60	85.6	0.43	
Burnet *[1]	104	74	85.9	T.	
Camp Eagle Pass †	110	63	89.0	0.15	
Childress	101	59	81.8	3.71	
Coleman *[3]	...	64	82.3	0.65	
Texas—Cont'd.	°	°	°	*Ins.*	*Ins.*
College Station [2]	101	...	85.4	1.45	
Columbia †	98	67	83.2	0.41	
Corsicana *b* †	106	64	85.4	0.47	
Cuero †	101	67	86.0	0.02	
Dallas †	105	61	85.6	1.14	
Danevang †	102	66	85.1	0.73	
Dean	103	52	77.2	1.71	
Dublin †	104	64	84.9	0.00	
Duval *[1]	111	77	90.5	0.30	
Emory	107	59	85.0	1.51	
Estelle †	107	58	85.4	1.08	
Forestburg †	105	60	82.8	4.22	
Fort Clark	106	62	86.2	0.10	
Fort McIntosh	107	69	88.6	0.80	
Fort Ringgold †	104	66	86.6	0.91	
Fort Stockton	...	...	...	1.48	
Fort Worth †	107[d]	64[d]	87.0[d]	0.55	
Fredericksburg *†[1]	102[b]	60	85.6[b]	1.14	
Fruitland	106	60	85.5	0.64	
Gainesville †	100	60	83.4	7.32	
Georgetown	...	...	...	0.17	
Grapevine †	105	58	85.4	0.08	
Hale Center †	101	56	77.6	3.72	
Hallettsville †	104	65	86.6	0.52	
Hearne †	105	70	86.8	0.00	
Henrietta †	106	65	87.0	1.43	
Hewitt	...	...	...	T.	
Houston †	99	70	84.8	2.00	
Huntsville †	102	66	86.2	0.30	
Junction City	108	...	...	2.01	
Kent	...	...	...	2.22	
Kerrville	...	54	...	0.80	
Lampasas †	108	58	85.4	0.42	
Langtry	105	...	...	0.00	
Llano *†[5]	108	70	88.8	0.40	
Longview †	108	62	87.2	3.03	
Lufkin †	108	64	87.4	0.12	
Luling †	103	67	86.4	0.88	
Mann	111[e]	66[e]	88.1[e]	0.43	
Marathon	95	49	79.5	0.38	
Menardville	105	55	81.6	0.00	
Midland	104	53	80.6	2.28	
Mount Blanco †	101	48	78.4	3.03	
New Braunfels †	101	65	84.4	1.19	
Orange †	95	67	82.2	1.03	
Paris †	108	60	85.2	2.27	
Point Isabel *[1]	92	78	84.2	0.00	
Rheinland †	105	56	84.6	3.34	
Roby	100	56	81.5	1.39	
Runge †	104[f]	69	88.4[f]	0.00	
San Antonio	104	68	86.9	0.37	
Sanderson †	104	49	82.4	0.50	
San Marcos *b* †	103	62	84.0	1.45	
Sierra Blanca †	97	...	...	4.09	
Stafford †	101	67	85.6	1.35	
Sulphur Springs †	107	63	86.4	2.24	
Temple *a*	104	68	86.4	0.30	
Temple *b*	104	62	86.6	0.10	
Tyler	106	66	86.2	1.16	
Valentine †	104	50	77.4	1.60	
Waco †	105	66	88.6	0.22	
Waxahachie †	112	61	87.0	0.40	
Weatherford †	106	62	85.3	0.17	
Wichita Falls †	...	...	...	2.15	
Utah.					
Alpine City †	...	...	...	0.54	
Blue Creek *[8]	102	48	74.4	0.10	
Brigham City †	...	...	...	1.03	
Castlegate	98	27	64.1	0.46	
Cisco †	105	47	78.0	0.65	
Corinne	98	40	69.7	0.58	
Croydon	94	29	63.7	0.40	
Ferron	95	45	71.8	0.48	
Fillmore †	115	35	72.8	0.19	
Fort Duchesne †	98	34	67.5	0.17	
Frisco	101	40	71.5	0.16	
Giles †	108	43	77.8	0.43	
Heber	97	30	63.0	0.56	
Huntsville	...	...	...	0.77	
Kelton *[8]	100	60	80.3	0.00	
Levan †	97	38	68.6	0.28	
Loa †	98	25	62.4	0.49	
Logan †	94	44	68.4	0.71	
Manti †	106	34	69.8	0.28	
Millville	...	...	...	0.74	
Minersville	96	40	71.0	0.91	
Moab †	95	48	73.9	0.80	
Mount Pleasant †	110	38	72.2	0.59	
Ogden *a* *[8]	98	49	77.5	T.	
Ogden *b*	97	43	71.9	0.47	
Pahreah	98	44	74.3	1.70	
Park City †	84	32	59.6	0.15	
Parowan †	97	39	68.7	0.79	
Pinto	95	34	66.6	0.90	
Promontory *[8]	103	31	72.8	0.25	
Richfield †	98	30	64.4	0.04	
Utah—Cont'd.	°	°	°	*Ins.*	*Ins.*
St. George †	110	49	80.4	0.28	
Scipio †	96	30	68.0	0.42	
Snowville	94	37	64.8	0.27	
Soldier Summit †	98	23	61.0	0.02	
Terrace *[8]	103	50	76.6	0.02	
Thistle †	97	35	67.2	0.58	
Tooele †	97	47	70.4	0.91	
Vernal	93	38	68.5	1.08	
Woodruff	90	30	55.0	0.20	
Vermont.					
Brattleboro	96	50	73.0	12.09	
Burlington †	96	59	74.4	8.48	
Chelsea †	92	52	69.7	10.60	
Cornwall	92	45[d]	73.7	8.71	
Enosburg Falls	94	50	70.4	12.73	
Hartland †	91	44	69.6	7.20	
Jacksonville	92	42	66.4	10.31	
St. Johnsbury	92	47	71.0	6.40	
Strafford *†[1]	89	49	69.0	6.85	
Vernon *[6]	95	56	73.5	13.65	
Wells	91	50	71.3	10.07	
Woodstock	99	45	73.4	6.04	
Virginia.					
Alexandria	94	59	77.7	4.65	
Ashland †	97	57	77.3	4.93	
Barboursville	90	58	76.0	4.50	
Bedford City	98	56	76.3	1.70	
Bigstone Gap †	94	46	71.2	6.78	
Birdsnest *†[1]	91	70	79.6	6.45	
Blacksburg	94	49	70.9	6.17	
Buckingham †	94	54	75.8	2.92	
Burkes Garden	88	47	70.4	4.61	
Callaville †	94	57	77.4	5.03	
Christiansburg †[4]	...	...	...	4.34	
Clifton Forge	97	51	73.7	3.78	
Dale Enterprise †	96	48	72.9	4.15	
Danville †	...	...	...	5.57	
Doswell	98	...	...	2.09	
Dwale	...	...	...	4.09	
Farmville	102	62	81.7	6.93	
Fredericksburg †	95	57	77.7	5.04	
Gordonsville	92	68	77.7	...	
Goshen	...	...	...	7.25	
Grahams Forge	92	47	71.1	4.75	
Hampton	91	65	79.5	3.27	
Hot Springs	92	58	75.8	3.26	
Leesburg	...	56	...	2.04	
Lexington †	90	54	73.9	3.99	
Maidens	...	...	...	3.72	
Manassas †	95	56	77.1	4.14	
Marion †	94[e]	48[e]	73.8[e]	4.97	
Monterey	86	48	68.7	4.23	
Petersburg †	99	59	78.7	2.72	
Quantico	93	55	77.4	...	
Richmond (near) †	100	60	79.1	3.74	
Rockymount †	95	57	76.9	1.91	
Salem †	95	61	77.0	3.64	
Speers Ferry	...	...	...	6.33	
Spottsville †	95	57	78.3	3.99	
Stanardsville †	92	54	74.0	7.70	
Staunton †	93	56	74.3	3.70	
Stephens City †	98	57	76.6	4.49	
Sunbeam †	94	60	78.5	4.13	
Swords Creek	...	...	...	6.81	
Warrenton	91	64	78.4	4.00	
Warsaw †	94	56	78.3	3.54	
Westbrook Farm	97	62	77.2	...	
Williamsburg	90	60	74.3	...	
Woodstock †	100	55	76.5	4.38	
Wytheville †	92	52	72.2	3.72	
Washington.					
Aberdeen	78	46	59.5	1.76	
Ashford †	...	...	...	3.06	
Blaine †	82	36	56.6	1.63	
Cascade Tunnel	90	33	52.8	0.49	
Centerville †	98	42	66.8	0.40	
Chehalis †	98	41	63.2	0.84	
Colfax †	95	40	60.2	1.16	
Coupeville †	75	45	58.3	1.46	
Ellensburg †	94	44	66.0	0.17	
Ellensburg (near)	102	46	67.3	0.27	
Fort Simcoe †	101	42	70.0	T.	
Fort Spokane	101	43	65.3	1.05	
Grandmound †	92	39	62.6	0.93	
Hunters †	86	35	56.0	2.87	
Kennewick †	107	45	72.1	0.63	
La Center	92	45	63.0	0.50	
Lakeside	95	47	68.0	0.88	
Lind	105	39	68.4	0.66	
Loomis †	98	47	69.4	0.88	
Madrone †	80	41	61.4	2.45	
Mayfield †	89	42	62.4	1.84	
Moxee Valley †	98	44	68.2	0.13	
New Whatcom	83	42	61.6	1.39	
Northbend	91	40	61.9	3.84	
Olga	71	43	57.8	1.38	

TABLE II.—*Meteorological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.)			Precipitation.	
	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Washington—Cont'd.	°	°	°	Ins.	Ins.
Olympia†	93	41	61.4	0.89	
Pinehill†	94	45	66.8	0.28	
Pomeroy	96	52	70.7	0.47	
Port Townsend	75	45	58.8	1.30	
Pullman†	94	41	62.0	0.59	
Rosalia†	93	37	61.0	1.18	
Sedro†	89	38	61.9	3.86	
Silvercreek*[1]	90	45	60.4	2.37	
Snohomish†	84	42	61.8	4.00	
Southbend	82	42	60.4	2.19	
Stillaguamish	83	39	59.4	2.92	
Sunnyside†	102	42	69.3	0.47	
Union City†	86	44	63.2	1.08	
Vashon†	82	45	61.1	1.10	
Waterville†	97	33	61.0	0.85	
Wenatchee Lake	92	38	60.7	......	
West Ferndale	85	39	56.8	2.00	
West Virginia.					
Beverly†	94	54	73.6	9.92	
Bluefield†	97	50	73.0	6.78	
Buckhannon *a*†	......	......	......	4.94	
Buckhannon *b*	99[f]	51[f]	75.2[f]	......	
Burlington†	96	53	73.7	4.16	
Charleston†	......	......	......	4.62	
Dayton†	......	......	......	7.03	
Elkhorn†	94	50	72.5	7.20	
Fairmont†	......	......	......	3.38	
Glenville†	92	54	74.0	8.93	
Grafton†	91	51	73.4	6.24	
Green Sulphur	91	54	73.7	4.98	
Harpers Ferry†	......	......	......	4.12	
Hewett†	101	53	78.1	7.46	
Hinton *a*†	......	......	......	5.03	
Hinton *b*†	98	54	75.6	......	
Huntington	97	55	76.0	6.04	
Kingwood	91	50	71.0	5.35	
Marlinton†	89	49	69.6	5.65	
Martinsburg†	95	56	76.1	2.85	
Morgantown *a*†	101	52	75.2	5.55	
New Martinsville†	97	54	77.3	7.33	
Nuttallburg†	96	35	72.2	8.20	
Oldfields†	94	51	73.2	2.97	
Philippi†	92	48	71.7	5.80	
Point Pleasant†	102	58	78.2	5.07	
Powellton	95	53	73.8	6.34	
Romney	95	55	76.7	3.68	
Rowlesburg†	......	......	......	4.47	
Tannery*[1]	91	53	68.3	......	
Weston *b**†[1]	96	56	75.7	......	
Wheeling *a*†	......	......	......	4.42	
Wheeling *b*†	101	61	79.4	5.69	
White Sulphur Springs†	93	46	75.9	6.59	
Wisconsin.					
Amherst	96	49	71.4	2.83	
Antigo	97	45	71.2[c]	4.08	
Barron	96	44	70.7	5.54	
Bayfield	91	46	69.0	8.21	
Beloit	95	54	75.4	2.42	
Butternut	100	42	73.2	15.11	
Chilton	98	51	72.4	2.03	
Citypoint	99	50	75.4	1.20	
Crandon†	98	51	74.0	1.75	
Delavan	97	50	73.7	2.32	
Dodgeville†	97	51	73.8	2.48	
Easton†	98	50	72.6	3.50	
Eau Claire	97	45	73.4	3.26	
Florence†	96	45	69.2	4.65	
Fond du Lac	97	54	72.4	2.19	
Grand River Locks	......	......	......	4.78	
Grantsburg†	95	48	72.0	9.67	
Hartford	......	......	......	2.75	
Hartland[f]	98	51	70.0	2.54	
Harvey	97	51	73.3	4.08	
Hillsboro	95	45	71.6	4.16	
Hudson	......	......	......	3.38	
Koepenick*†[1]	96	56	68.4	3.70	
Lancaster†	98	51	74.4	2.08	
Lincoln†[2]	......	......	72.4	3.52	
Madison†	95	57	75.3	1.79	
Manitowoc†	90	53	69.6	2.46	
Meadow Valley†	98	46	71.9	2.37	
Medford†	101	41	71.1	5.27	
Wisconsin—Cont'd.	°	°	°	Ins.	Ins.
Menasha	......	......	......	3.19	
Neillsville†	94	48	71.8	2.93	
New Holstein	98	51	71.7	1.50	
New London	95	52	72.4	3.62	
Oconto	96	50	72.1	4.49	
Osceola†	93	46	71.2	4.94	
Oshkosh†	94	52	73.2	3.64	
Pepin	96	47	73.8	4.73	
Pine River†	95	49	72.7	2.89	
Portage†	99	48	73.4	3.51	
Port Washington	95	51	70.8	3.56	
Prairie du Chien	102	53[d]	76.4	4.68	
Racine	96	54	73.5	1.93	
Sharon†	96	47	72.4	1.96	
Shawano	94	49	71.6	3.68	
Spooner†	97	52[k]	75.9[f]	5.05	
Stevens Point†	96	51	73.0	2.34	
Sturgeon Bay Canal*[10]	85	54	68.8	......	
Valley Junction†	95	46	71.4	2.26	
Viroqua	93	52	72.4	3.98	
Watertown†	95	51	72.7	3.93	
Waukesha†	95	54	73.4	3.20	
Waupaca†	98	52	73.7	2.24	
Wausau†	97	50	72.6	3.42	
Wausaukee	96	52	72.8	6.54	
Westbend	96	54	72.6	2.09	
Westfield†	98	51	73.2	2.88	
Whitehall	99	44	74.4	4.58	
White Mound†	99	49	73.9	4.20	
Wyoming.					
Atlantic City	90	28	60.5	2.26	
Big Horn Ranch	89	32	59.9	1.09	
Carbon	103	37	66.6	1.20	
Fort Laramie†	104	41	71.0	0.99	
Fort Yellowstone†	89	32	60.2	1.11	
Laramie	85	36	60.7	1.29	
Lusk†	105	37	69.7	1.05	
Sheridan	96	41	65.2	0.16	
Strong	94	33	66.0	0.58	
Sundance	88	43	64.6	1.98	
Wamsutter	105	30	65.8	0.03	
Wheatland	102	45	73.0	0.93	
Mexico.					
Ciudad P. Diaz	101	69	88.2	0.13	
Leon de Aldamas	84	55	69.5	8.32	
Topolobampo*[1]	95	79	85.5	1.67	
New Brunswick.					
St. John	75	48	60.5	2.74	
West Indies.					
Grand Turk Island	......	......	......	0.98	
Iowa.	°	°	°	Ins.	Ins.
Rockwell City	......	......	......	0.92	
Kansas.					
Goodland	101	45	74.0	3.41	
Minnesota.					
Campbell	93	25	61.6	5.40	
Granite Falls	92	36	64.4	4.14	
Winnebago City	94	35	67.4	3.96	
Nebraska.					
State Farm	102	39	73.0	2.01	
Nevada.					
Gold Creek*[1]	82	26	56.4	0.57	0.8
New Jersey.					
Readington*[6]	92	56	70.5	......	
North Carolina.					
Horse Cove	90	51	71.5	6.81	
North Dakota.					
Lisbon	96	29	61.8	5.13	
Neche	96[c]	25[c]	61.6[c]	1.32	
Oklahoma.					
Edmond	......	......	......	2.09	
South Dakota.					
Faulkton	96	28	63.4	5.18	
Texas.					
Henrietta	100	52	78.0	4.96	
Mount Blanco	108	43	75.8	3.06	
Virginia.					
Doswell	......	......	......	2.38	
Washington.					
Pomeroy	86	42	62.2	4.38	
Mexico.					
Topolobampo*[1]	93	76	83.7	0.00	

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Alaska.					
Coal Harbor	68	33	46.8	2.35	
Arizona.					
Dragoon	......	......	......	0.00	
Dudleyville	104	44	77.4	0.36	
Gisela*	107	39	75.2	0.20	
Arkansas.					
Moore	......	......	......	6.32	
Powell	......	......	......	4.87	
California.					
Coronado	77	60	67.0	0.00	
Fordyce Dam	......	......	......	5.76	7.0
Manzana	97	40	67.0	T.	
Marysville	106	54	73.0	T.	
Morena Dam	90	40	65.0	0.00	
Napa *b*	104	44	66.0	0.46	
Point Lobos	71	47	56.0	0.25	
Tecarte Dam*[4]	106	38	62.0	0.00	
Tulare *c*	108	48	74.0	0.00	
Colorado.					
Cope	95	39	68.0	3.24	
Fleming	......	......	......	2.92	
Indiana.					
Princeton	......	......	......	4.77	
Indian Territory.					
Afton	88	47	68.6	4.35	

EXPLANATION OF SIGNS.

* Extremes of temperature from observed readings of dry thermometer.

† Weather Bureau instruments.

‡ Record furnished by the Arrowhead Reservoir Company, in the San Bernardino Mountains, San Bernardino County, Cal., at elevations varying from 5,150 to 5,350 feet.

A numeral following the name of a station indicates the hours of observation from which the mean temperature was obtained, thus:

[1] Mean of 7 a. m + 2 p. m. + 9 p. m. + 9 p. m. ÷ 4.
[2] Mean of 8 a. m. + 8 p. m. ÷ 2.
[3] Mean of 7 a. m. + 7 p. m. ÷ 2.
[4] Mean of 6 a. m. + 6 p. m. ÷ 2.
[5] Mean of 7 a. m. + 2 p. m. ÷ 2.
[6] Mean of readings at various hours reduced to true daily mean by special tables.
[7] Mean from hourly readings of thermograph.
[8] Mean of 7 a. m. + 2 p. m. + 9 p. m. ÷ 3.
[9] Mean of sunrise and noon.
[10] Mean of sunrise, noon, sunset, and midnight.

The absence of a numeral indicates that the mean temperature has been obtained from daily readings of the maximum and minimum thermometers.

An italic letter following the name of a station, as "Livingston *a*," "Livingston *b*," indicates that two or more observers, as the case may be, are reporting from the same station. A small roman letter following the name of a station, or in figure columns, indicates the number of days missing from the record; for instance, "n" denotes 14 days missing.

No note is made of breaks in the continuity of temperature records when the same do not exceed two days. All known breaks, of whatever duration, in the precipitation record receive appropriate notice.

CORRECTIONS.

California, Oleta, June, 1897, make mean temperature 65.5 instead of 64.9.

Texas, June, 1897, page 272, make Henrietta read Kerrville.

Maryland, Port Deposit, May, 1897, make precipitation 5.51 instead of 5.16.

The following changes have been made in names of stations:

Kentucky, Maurice, changed to Scott.

TABLE III.—*Data from Canadian stations for the month of July, 1897.*

Stations.	Pressure. Mean not reduced.	Pressure. Mean reduced.	Pressure. Departure from normal.	Temperature. Mean.	Temperature. Departure from normal.	Precipitation. Total.	Precipitation. Departure from normal.	Prevailing direction of wind.	Total depth of snow.
	Inches.	*Inches.*	*Inches.*	°	°	*Inches*	*Inches.*		
St. Johns, N. F	29.79	29.93	− .04	56.8	− 4.2	6.09	....	w.	
Sydney, C. B. I	29.97	30.03	+ .12	64.6	+ 3.1	1.45	− 3.05	sw.	
Grindstone, G. St. L.	....	....	....	....	....	....	....	.....	
Halifax, N. S	29.94	30.07	+ .15	64.1	+ 1.6	3.65	− 0.60	sw.	
Grand Manan, N. B.	29.96	30.01	+ .06	60.4	− 1.3	3.29	− 0.55	w.	
Yarmouth, N. S.	29.98	30.06	+ .13	60.8	+ 0.8	3.93	+ 0.86	s.	
Charlottet'n, P. E. I.	29.97	30.01	+ .09	65.0	+ 1.0	4.52	+ 0.55	sw.	
Chatham, N. B	29.96	29.98	+ .10	66.8	+ 3.8	3.32	− 1.38	w.	
Father Point, Que.	29.94	29.97	+ .13	57.7	+ 0.7	3.14	− 0.08	w.	
Quebec, Que	29.63	29.95	+ .08	67.2	+ 2.2	3.85	− 0.11	ne.	
Montreal, Que	29.72	29.92	+ .04	70.6	+ 2.1	4.42	− 0.15	sw.	
Rockliffe, Ont	29.40	29.89	.00	68.6	+ 5.6	3.09	− 0.03	se.	
Kingston, Ont	29.61	29.92	+ .02	70.2	+ 2.2	4.53	+ 1.27	sw.	
Toronto, Ont	29.54	29.91	− .03	71.2	+ 3.7	5.24	+ 2.27	w.	
White River, Ont	28.60	29.90	− .05	67.2	+ 6.5	1.49	− 1.82	n.	
Port Stanley, Ont	29.30	29.92	− .05	70.1	+ 2.3	5.16	+ 1.61	w.	
Saugeen, Ont	29.23	29.92	− .01	68.9	+ 5.4	3.36	+ 1.33	sw.	
Parry Sound, Ont	29.24	29.91	− .01	70.6	+ 5.6	6.92	+ 4.49	w.	
Port Arthur, Ont	29.18	29.86	− .02	64.2	+ 0.7	6.53	+ 3.52	w.	
Winnipeg, Man	29.00	29.80	− .09	67.4	+ 3.4	5.38	+ 2.16	se.	
Minnedosa, Man	28.09	29.83	− .01	65.4	+ 3.9	1.77	− 0.77	nw.	
Qu'Appelle, Assin	27.62	29.81	− .05	63.0	0.0	1.77	− 0.68	s.	
Medicine Hat, Assin	27.58	29.81	− .03	64.7	− 2.8	1.65	− 0.07	s.	
Swift Curr't, Assin.	27.34	29.84	− .06	64.5	0.0	6.27	+ 4.15	w.	
Calgary, Alberta	26.37	29.83	− .07	57.5	− 1.5	5.54	+ 2.96	w.	
Prince Albert, Sask.	28.25	29.72	....	60.6	− 1.3	2.35	....	w.	
Edmonton, Alberta.	27.58	29.87	− .02	58.1	− 2.8	4.19	+ 1.09	se.	
Battleford, Sask	28.12	29.80	....	61.8	− 2.9	4.67	....	w.	
Kamloops, B. C.	....	....	....	....	....	....	....	.....	
Hamilton, Bermuda	30.01	30.17	+ .03	78.4	− 0.3	5.79	....	s.	
Banff, Alberta	25.33	29.89	....	52.6	....	5.34	....	sw.	
Esquimalt, B. C.	30.04	30.07	....	56.5	− 3.5	1.00	....	s.	
Ottawa, Ont	29.60	29.95	....	71.2	+ 1.7	5.21	....	e.	
June, 1897.									
Medicine Hat, Assin	27.57	29.81	+ .02	61.2	− 2.3	5.62	+ 2.59	n.	

Table IV not received.

TABLE V.—*Mean temperature for each hour of seventy-fifth meridian time, July, 1897.*

Stations.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	Noon.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	Midnight.	Mean.
Bismarck, N Dak	64.4	63.3	62.6	61.5	60.5	59.5	59.4	61.7	63.8	67.5	71.0	74.0	76.3	78.0	79.4	80.5	80.5	79.4	78.5	76.7	74.5	70.7	68.1	66.1	69.9
Boston, Mass	67.5	67.0	66.9	66.6	66.4	66.9	68.5	69.8	71.8	73.2	73.9	74.8	75.2	75.9	74.9	74.9	74.3	74.2	72.6	71.0	70.1	69.4	68.9	68.2	71.0
Buffalo N Y	69.7	69.4	69.0	68.6	68.5	69.3	70.7	71.3	73.5	75.4	76.5	77.7	78.7	79.3	79.5	78.6	77.7	76.8	75.4	74.9	73.5	72.4	71.5	70.5	73.7
Chicago, Ill	71.8	71.1	70.2	69.9	69.4	69.2	70.5	72.2	73.9	74.9	75.5	76.3	76.5	77.4	77.9	77.7	77.9	77.8	77.0	76.0	75.1	74.2	73.6	73.1	74.1
Cincinnati, Ohio	74.2	73.1	72.3	71.3	70.4	69.8	70.4	72.1	74.2	76.9	79.1	81.1	82.7	83.5	84.1	84.7	84.7	84.3	83.0	81.2	80.1	78.6	77.1	75.6	77.7
Cleveland, Ohio	71.1	70.3	69.3	68.9	68.5	68.3	68.9	70.8	73.5	74.6	76.1	76.5	76.4	76.4	76.9	77.7	78.3	78.4	78.4	77.0	75.5	74.5	73.1	71.9	73.8
Detroit, Mich	71.3	70.2	69.2	68.7	68.1	67.7	68.8	71.4	73.6	75.5	77.2	78.5	79.4	80.0	80.4	80.3	80.4	80.5	79.2	77.3	75.2	74.1	73.0	72.0	74.7
Dodge City, Kans	72.7	71.3	69.9	68.8	67.9	67.0	66.1	68.5	72.6	77.0	80.3	83.5	86.5	88.3	89.7	90.4	90.2	90.1	88.7	86.4	82.8	79.2	76.7	75.0	78.7
Eastport, Me	54.3	54.1	53.7	53.8	54.1	55.2	56.3	57.8	59.9	60.9	61.6	62.3	62.6	62.6	62.3	62.2	61.7	61.2	58.9	57.3	56.7	55.9	55.0	54.9	58.1
Galveston, Tex	82.2	82.0	81.8	81.5	81.2	80.8	80.7	82.0	82.3	83.7	85.1	86.1	86.6	87.2	87.2	87.3	87.2	86.3	85.4	84.3	83.3	82.8	82.6	82.5	83.8
Havre, Mont	61.3	60.1	58.7	57.4	56.3	54.7	53.8	55.4	58.7	61.8	65.3	68.3	71.2	72.9	74.5	75.6	76.2	76.9	76.9	76.1	74.4	70.8	66.5	63.7	66.1
Kansas City, Mo	76.0	74.9	74.1	73.6	72.7	72.0	71.8	72.9	75.8	78.6	81.0	83.4	85.4	86.9	87.7	88.4	88.6	87.8	86.5	84.9	82.5	80.4	78.7	77.4	80.1
Key West, Fla	80.9	80.8	80.9	80.5	80.5	80.5	81.3	82.7	83.6	84.0	84.8	84.9	85.0	85.2	85.2	85.1	85.0	84.1	83.6	83.0	82.2	81.6	81.1	81.0	82.8
Memphis, Tenn	78.9	77.6	76.5	75.7	75.2	74.5	74.6	76.3	78.4	80.3	82.6	84.7	86.4	87.5	88.1	88.8	88.4	88.1	87.4	85.9	83.6	82.5	81.2	80.0	81.8
New Orleans, La	79.6	79.1	78.7	78.5	78.2	77.6	77.9	80.3	82.7	84.5	85.9	86.5	88.6	87.8	87.6	87.0	87.2	86.6	85.4	84.1	82.7	81.7	80.9	80.3	82.9
New York, N. Y	69.1	68.7	68.1	67.8	67.4	67.5	68.4	69.9	71.6	73.4	74.3	75.5	75.9	76.6	76.1	74.4	74.2	73.6	73.1	72.5	71.4	70.7	70.4	69.6	71.7
Philadelphia, Pa	71.0	70.6	70.2	69.8	69.6	70.0	71.4	73.0	75.2	77.1	78.6	80.2	81.6	82.7	82.5	81.8	81.3	79.1	77.4	75.8	74.0	73.0	72.0	71.5	75.4
Pittsburg, Pa	71.6	70.8	70.3	69.5	68.7	68.5	69.9	72.4	75.3	77.4	79.4	80.6	82.0	82.7	82.4	82.9	83.0	82.2	79.5	77.4	76.1	75.0	73.3	72.1	76.0
Portland, Oreg	63.5	61.9	60.5	59.3	58.2	57.1	56.3	55.7	55.8	57.5	59.0	60.6	62.9	64.8	66.6	68.6	70.7	71.8	72.8	71.9	71.4	70.1	67.7	65.1	63.7
St. Louis, Mo	76.6	75.9	74.9	74.3	73.5	73.2	73.4	75.4	77.7	79.4	81.1	83.4	85.2	86.2	86.9	87.4	87.7	86.9	85.6	84.0	82.1	80.6	79.2	78.2	80.4
St. Paul, Minn	70.6	69.6	68.7	68.0	67.2	66.2	66.4	68.2	70.6	72.8	74.9	76.8	78.3	79.0	80.0	80.1	80.9	80.9	80.0	78.7	76.3	74.1	72.4	71.4	73.8
Salt Lake City, Utah	69.4	68.0	66.7	65.7	64.9	64.0	63.7	63.5	65.6	68.9	72.3	75.2	77.6	78.8	80.5	81.3	81.9	82.3	82.5	81.9	79.9	76.4	72.8	71.1	73.1
San Diego, Cal	64.5	64.4	64.1	63.8	63.8	63.8	63.6	63.6	63.8	64.7	66.0	67.7	68.8	69.4	70.0	70.1	70.1	69.9	69.3	68.8	67.8	66.3	65.3	64.8	66.4
San Francisco, Cal	54.0	53.7	53.2	53.0	52.6	52.5	52.3	52.5	52.7	53.8	55.4	57.5	59.7	61.4	62.3	63.1	62.8	62.1	60.9	59.0	58.0	56.5	54.9	54.5	56.6
Savannah, Ga	76.7	76.0	75.3	75.0	74.6	74.3	75.7	79.1	82.1	84.5	86.9	87.7	88.2	88.3	87.5	85.8	84.3	83.3	82.3	80.8	79.5	78.8	78.1	77.5	80.9
Washington, D. C	71.8	71.1	70.5	69.7	69.4	69.4	71.0	73.5	75.6	77.7	79.7	81.2	83.1	83.5	83.6	83.1	82.3	81.7	79.3	77.4	75.9	74.6	73.5	72.6	76.3

TABLE VI.—*Mean pressure for each hour of seventy-fifth meridian time, July, 1897.*

Stations.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	Noon.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	Midnight.	Mean.
Bismarck, N. Dak	28.125	.126	.126	.122	.126	.132	.137	.146	.151	.149	.147	.144	.135	.125	.116	.110	.104	.098	.095	.096	.098	.106	.119	.123	.123
Boston, Mass	29.845	.840	.837	.835	.839	.847	.856	.858	.856	.855	.853	.853	.845	.839	.834	.828	.826	.829	.836	.845	.854	.853	.854	.851	.844
Buffalo, N. Y	29.111	.108	.107	.110	.119	.127	.134	.136	.136	.134	.133	.129	.122	.111	.102	.098	.100	.101	.103	.105	.113	.117	.119	.119	.116
Chicago, Ill	29.078	.073	.073	.073	.079	.086	.095	.102	.106	.109	.109	.108	.102	.095	.087	.079	.071	.067	.060	.058	.067	.074	.076	.076	.083
Cincinnati, Ohio	29.299	.298	.294	.293	.299	.307	.316	.325	.328	.327	.328	.323	.316	.302	.293	.282	.277	.276	.279	.285	.292	.303	.308	.306	.302
Cleveland, Ohio	29.132	.129	.129	.131	.136	.143	.148	.152	.162	.163	.161	.156	.149	.142	.132	.122	.116	.113	.116	.117	.131	.138	.140	.141	.138
Detroit, Mich	29.162	.161	.157	.156	.162	.167	.176	.179	.182	.180	.179	.176	.169	.160	.153	.145	.140	.136	.141	.147	.157	.165	.169	.170	.162
Dodge City, Kans	27.390	.391	.386	.385	.381	.386	.397	.406	.414	.417	.415	.409	.402	.391	.376	.359	.349	.339	.334	.340	.350	.361	.376	.385	.381
Eastport, Me	29.908	.905	.904	.908	.914	.919	.925	.930	.934	.935	.932	.929	.923	.917	.913	.908	.904	.906	.911	.914	.918	.920	.919	.917	.917
Galveston, Tex	29.997	.993	.986	.982	.987	.994	.001	.007	.015	.021	.027	.028	.023	.015	.000	.986	.973	.963	.963	.970	.975	.983	.995	.997	.995
Havre, Mont	27.281	.284	.284	.283	.283	.285	.293	.299	.305	.307	.303	.297	.295	.287	.279	.272	.265	.257	.254	.252	.256	.263	.277	.282	.281
Kansas City, Mo	28.955	.954	.953	.953	.956	.965	.974	.982	.989	.986	.985	.980	.970	.960	.951	.940	.928	.921	.918	.924	.929	.940	.946	.951	.955
Key West, Fla	30.046	.033	.020	.020	.018	.022	.033	.047	.055	.060	.064	.062	.054	.043	.028	.021	.014	.015	.025	.035	.046	.054	.058	.055	.039
Memphis, Tenn	29.578	.574	.566	.565	.567	.574	.585	.595	.611	.616	.618	.620	.609	.598	.579	.565	.552	.545	.538	.543	.556	.567	.573	.576	.578
New Orleans, La	29.957	.953	.950	.951	.957	.968	.981	.994	.999	.000	.997	.992	.980	.970	.957	.944	.933	.929	.933	.941	.948	.958	.963	.963	.963
New York, N. Y	29.640	.635	.635	.637	.641	.648	.656	.662	.663	.662	.660	.655	.648	.640	.630	.627	.625	.627	.632	.637	.647	.651	.651	.649	.644
Philadelphia, Pa	29.844	.840	.839	.842	.846	.854	.862	.869	.870	.870	.866	.860	.846	.835	.826	.820	.819	.824	.830	.836	.846	.851	.852	.851	.846
Pittsburg, Pa	29.089	.088	.084	.088	.094	.100	.109	.111	.113	.112	.108	.100	.093	.082	.071	.063	.058	.058	.068	.078	.083	.088	.093	.094	.088
Portland, Oreg	29.914	.922	.929	.932	.935	.937	.941	.946	.952	.955	.958	.957	.955	.951	.943	.934	.919	.910	.904	.895	.894	.896	.905	.916	.929
St. Louis, Mo	29.371	.368	.365	.365	.372	.380	.392	.403	.409	.410	.408	.404	.396	.385	.373	.364	.351	.344	.343	.345	.353	.361	.369	.372	.375
St. Paul, Minn	29.011	.010	.010	.012	.009	.010	.016	.021	.022	.025	.025	.026	.020	.013	.004	.998	.990	.987	.979	.980	.986	.001	.011	.012	.007
Salt Lake City, Utah	25.662	.663	.661	.661	.664	.667	.676	.687	.696	.705	.711	.710	.706	.697	.686	.674	.665	.649	.639	.636	.636	.644	.653	.660	.671
San Diego, Cal	29.863	.862	.860	.850	.845	.844	.843	.849	.861	.871	.875	.878	.880	.880	.876	.869	.860	.851	.843	.835	.838	.843	.852	.861	.858
San Francisco, Cal	29.809	.807	.802	.799	.795	.795	.800	.805	.818	.828	.836	.839	.840	.838	.830	.821	.809	.797	.789	.781	.781	.786	.796	.806	.809
Savannah, Ga	29.928	.922	.917	.918	.926	.935	.946	.955	.963	.964	.962	.957	.941	.927	.915	.906	.902	.904	.915	.922	.934	.940	.942	.940	933
Washington, D. C	29.853	.848	.843	.845	.853	.861	.871	.876	.875	.878	.875	.871	.861	.848	.837	.831	.828	.829	.834	.839	.851	.860	.863	.862	.854

TABLE VII.—*Average wind movement for each hour of seventy-fifth meridian time, July, 1897.*

Stations.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	Noon.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	Midnight.	Mean.
Abilene, Tex	7.8	7.6	7.9	8.1	8.0	7.5	7.6	7.5	8.2	10.2	10.8	10.9	11.5	10.1	9.6	10.2	10.5	10.6	10.4	10.1	8.4	7.6	7.8	7.9	9.0
Albany, N. Y	4.5	4.4	4.5	4.7	4.6	4.0	4.4	5.2	6.2	6.2	6.8	7.5	8.3	8.7	9.2	8.9	8.6	7.9	6.3	5.6	5.3	5.1	5.0	5.1	6.1
Alpena, Mich	5.3	5.3	5.4	5.1	5.6	6.1	6.5	6.5	7.5	8.2	9.5	9.9	11.0	11.0	11.3	11.3	11.3	10.0	8.5	7.5	5.8	5.4	5.1	5.1	7.7
Amarillo, Tex	14.8	14.5	13.9	14.1	14.3	13.8	14.0	12.2	12.7	14.7	15.1	14.5	14.5	14.3	14.2	14.6	16.0	17.0	17.7	18.4	17.4	15.7	14.6	15.1	14.9
Atlanta, Ga	6.8	7.5	6.8	6.9	6.6	6.8	6.2	5.9	6.1	7.2	7.9	8.5	8.3	8.5	9.0	9.4	9.1	8.2	7.1	6.6	6.2	6.6	7.3	7.2	7.4
Atlantic City, N. J	7.4	7.6	7.3	6.7	6.8	6.6	7.7	8.6	9.0	9.2	9.6	10.0	10.4	10.9	11.3	10.8	9.8	10.0	8.6	8.1	8.0	7.7	7.7	7.0	8.6
Augusta, Ga	3.2	3.4	3.1	2.9	2.8	2.8	2.9	3.5	4.3	4.6	4.9	5.5	6.8	7.3	7.4	7.7	7.5	7.2	6.5	5.5	4.6	4.0	3.6	3.8	4.8
Baker City, Oreg	4.0	3.9	3.9	4.9	5.9	6.8	7.1	7.2	6.8	5.0	3.4	3.8	4.5	5.4	6.2	7.2	7.6	8.1	8.0	8.2	7.6	6.3	4.9	4.4	5.9
Baltimore, Md	2.8	3.4	3.0	3.5	3.5	3.5	3.6	4.4	5.1	5.7	5.9	6.5	6.9	7.4	7.1	7.6	7.3	5.9	4.8	4.0	3.8	3.2	2.9	2.9	4.8
Bismarck, N. Dak	7.1	6.0	7.0	6.6	6.3	6.6	6.4	6.0	6.8	7.9	8.4	9.1	10.3	10.8	11.3	11.3	11.1	10.7	10.8	10.7	9.2	7.7	7.9	7.8	8.5
Block Island, R. I	12.8	12.8	12.7	13.2	13.2	12.8	13.0	14.3	14.8	15.0	15.2	15.2	15.5	15.6	15.1	15.9	15.4	15.2	14.5	14.4	14.0	14.1	13.5	12.9	14.2
Boston, Mass	8.7	9.2	9.1	9.3	9.4	9.0	9.3	9.8	10.8	11.3	12.5	12.0	12.5	13.3	13.4	12.9	12.0	11.6	11.6	10.7	10.2	10.0	9.3	9.2	10.7
Buffalo, N. Y	11.8	11.8	10.5	10.7	10.1	9.9	9.5	10.2	11.3	11.7	12.3	12.3	13.2	13.0	13.2	13.9	13.3	12.8	11.2	10.4	10.0	10.3	10.6	11.9	11.5
Cairo, Ill	4.8	4.7	5.0	4.8	4.6	4.8	4.7	5.3	5.9	6.3	6.6	6.7	7.5	7.9	7.5	7.7	7.4	6.9	6.7	6.2	5.0	5.1	5.5	5.2	5.9
Cape Henry, Va	7.5	7.5	8.3	7.5	7.5	6.8	7.7	8.5	8.4	9.1	9.2	10.0	10.2	10.6	10.6	11.1	11.0	10.4	9.7	9.2	8.7	8.5	8.5	8.4	9.0
Carson City, Nev	5.9	5.2	4.7	3.8	3.1	2.3	2.1	2.1	2.2	1.7	2.8	4.0	5.4	7.6	8.9	11.0	12.7	12.7	13.8	13.6	12.5	10.9	9.1	7.0	6.9
Charleston, S. C	7.3	6.6	6.8	6.0	6.2	6.7	6.9	7.0	7.1	8.0	8.6	9.0	10.5	11.3	12.2	11.8	11.5	10.6	9.7	8.9	7.7	8.0	7.1	7.3	8.4
Charlotte, N. C	3.5	3.1	3.3	3.6	3.3	3.5	2.9	3.7	4.4	4.7	4.6	5.4	5.6	5.5	6.3	6.7	5.7	6.3	4.4	3.6	3.7	3.6	4.0	3.9	4.4
Chattanooga, Tenn	3.7	3.9	4.2	3.7	4.1	4.2	4.1	4.2	4.6	4.8	6.2	7.0	7.9	8.2	9.3	9.5	8.6	8.7	8.0	7.4	5.7	4.6	4.5	4.0	5.9
Cheyenne, Wyo	6.7	7.0	6.8	6.4	7.1	6.7	6.5	6.5	7.0	7.8	9.3	10.5	12.1	12.0	11.3	10.2	11.7	11.1	9.9	9.5	9.4	8.5	8.9	7.8	8.8
Chicago, Ill	13.2	12.6	12.4	11.4	10.7	11.1	11.6	12.4	12.8	12.9	12.6	13.2	14.5	15.3	16.0	16.4	16.1	15.3	15.2	13.9	13.2	13.5	12.6	12.3	13.4
Cincinnati, Ohio	4.6	4.5	4.5	4.0	4.5	3.7	4.1	5.3	5.8	6.6	6.9	7.6	8.5	8.8	9.3	9.5	9.4	9.1	8.5	7.4	5.7	5.1	4.7	4.6	6.4
Cleveland, Ohio	10.2	10.2	10.7	10.2	10.0	9.6	9.7	9.5	9.7	10.2	10.9	11.5	12.7	12.4	13.2	13.2	12.0	10.6	10.8	9.8	9.9	10.1	10.2	10.3	10.7
Columbia, Mo	5.8	5.4	5.8	6.0	5.4	4.9	5.4	5.4	5.9	6.7	7.2	7.5	8.1	8.1	8.2	8.4	8.0	7.8	6.3	5.2	5.1	5.7	6.5	5.7	6.4
Columbus, Ohio	4.2	3.8	3.7	4.0	3.8	3.9	3.6	4.0	4.8	5.5	6.1	6.8	7.5	7.9	8.5	9.2	8.7	8.1	6.8	5.1	5.4	5.4	4.9	4.2	5.7
Concordia, Kans	6.2	6.0	6.1	5.5	5.0	5.4	5.6	6.2	6.8	7.7	8.2	8.8	9.0	9.2	9.3	9.0	8.8	8.4	7.5	6.5	5.0	5.7	7.0	7.1	7.1
Corpus Christi, Tex	12.0	10.0	8.3	7.2	6.6	5.5	4.8	4.8	7.0	8.9	9.9	11.8	15.1	16.5	17.9	18.5	18.6	18.5	18.6	17.9	17.1	15.9	14.4	13.3	12.5
Davenport, Iowa	4.7	4.7	4.5	4.3	4.6	4.3	5.1	5.5	6.2	7.1	8.1	8.7	9.4	9.2	9.1	9.3	9.4	9.1	8.6	7.1	5.2	5.0	5.1	4.7	6.6
Denver, Colo	7.6	7.8	7.1	7.2	6.7	6.9	7.1	7.3	6.6	6.6	7.0	6.6	7.2	7.4	7.8	8.1	9.1	10.4	10.4	8.7	8.1	7.0	6.8	7.4	7.6
Des Moines, Iowa	5.7	5.1	5.4	5.4	5.6	5.2	5.3	6.1	6.9	7.9	9.2	9.6	10.5	10.0	10.3	11.3	10.8	10.5	9.7	8.0	6.4	6.0	5.8	5.6	7.6
Detroit, Mich	5.8	6.1	6.3	5.8	5.9	6.3	5.9	6.6	7.3	7.7	8.1	9.3	10.2	10.3	10.7	10.5	10.2	9.3	8.0	6.5	6.1	5.6	5.8	5.7	7.5
Dodge City, Kans	11.4	10.7	10.2	8.9	7.6	6.8	6.9	7.3	9.8	12.5	14.3	15.3	15.1	15.5	16.1	16.2	16.7	16.0	16.1	14.8	12.2	10.5	11.2	11.1	12.2
Dubuque, Iowa	4.3	3.9	4.1	3.5	3.5	3.7	3.6	4.9	5.2	6.4	7.0	8.3	8.4	8.5	8.5	8.5	8.2	8.4	7.6	6.5	5.3	4.9	4.6	4.7	5.9
Duluth, Minn	7.2	8.0	7.4	7.5	7.0	7.3	7.7	6.8	7.2	7.7	8.3	8.2	10.1	10.2	10.0	10.0	10.1	9.2	7.2	6.5	6.3	7.0	6.8	6.5	7.9
Eastport, Me	7.1	6.9	6.9	7.0	6.6	7.0	7.2	8.2	7.9	9.2	10.1	10.3	11.0	11.7	11.7	11.5	10.0	9.1	8.6	8.2	8.3	8.3	8.4	7.8	8.7
El Paso, Tex	8.7	8.8	8.9	10.1	10.4	9.7	9.6	8.8	8.0	8.5	8.7	9.5	9.9	10.5	10.5	10.4	10.9	10.8	10.7	11.6	12.2	10.7	9.4	8.1	9.8
Erie, Pa	8.8	9.0	8.7	9.0	9.2	8.8	8.6	9.5	9.7	10.4	10.5	10.1	10.8	10.6	10.4	9.7	9.1	8.5	7.5	7.9	8.5	8.9	9.5	9.4	9.3
Eureka, Cal	6.3	6.2	5.5	4.8	4.2	4.2	4.0	4.5	4.4	4.4	5.2	6.4	8.2	10.0	12.3	13.2	13.3	13.9	12.9	12.5	11.6	10.1	9.5	8.1	8.2
Fort Canby, Wash	9.4	9.7	9.7	8.9	9.0	9.0	8.7	8.3	8.1	8.0	8.5	8.3	8.1	8.9	10.0	10.7	10.9	11.6	11.3	11.2	10.7	10.1	9.9	9.3	9.5
Fort Smith, Ark	3.7	3.6	3.2	3.3	3.8	4.5	4.5	4.4	4.9	5.5	5.4	5.8	6.8	6.5	6.9	7.5	7.8	7.9	7.1	5.6	4.6	4.2	3.5	3.8	5.2
Fresno, Cal	10.5	10.2	9.7	8.8	8.0	6.7	6.2	4.4	4.0	3.1	3.8	4.2	4.9	4.9	4.8	5.1	5.5	5.6	6.6	7.0	7.2	8.2	8.7	9.5	6.6
Galveston, Tex	9.0	9.0	9.0	8.5	7.8	7.3	6.0	6.4	7.7	8.3	8.8	9.5	10.5	10.9	12.0	12.5	12.2	12.3	10.9	11.0	10.1	9.7	9.6	9.3	9.5
Grand Haven, Mich	6.0	5.9	5.6	6.4	6.3	6.0	5.9	6.5	7.8	8.4	9.3	9.8	10.5	11.3	11.6	11.0	10.2	9.0	8.0	6.7	6.5	5.7	5.6	5.5	7.7
Greenbay, Wis	5.0	5.4	5.3	4.7	4.4	4.5	4.7	5.4	6.5	7.1	7.4	8.2	8.8	9.0	9.1	8.9	8.8	8.1	7.5	6.9	6.0	5.6	5.2	5.3	6.6
Hannibal, Mo	5.7	5.2	5.6	6.2	5.9	5.8	5.3	5.5	7.0	7.8	8.7	9.6	9.8	10.0	10.3	9.8	9.9	8.9	7.3	6.1	5.1	5.6	6.6	6.3	7.2
Harrisburg, Pa	4.7	4.6	4.6	4.5	4.3	4.3	4.2	5.5	6.2	6.8	7.1	7.9	8.2	8.7	8.9	8.8	8.1	8.1	7.7	7.0	5.9	5.4	4.9	4.5	6.3
Hatteras, N. C	8.5	8.7	9.0	8.2	8.2	7.6	7.5	8.5	8.8	8.3	8.6	8.6	9.6	11.0	11.1	11.5	10.8	10.3	9.6	9.2	9.2	9.4	9.5	8.6	9.2
Havre, Mont	6.2	5.5	6.5	7.6	7.3	7.3	8.5	8.5	9.2	11.0	12.3	12.6	13.7	12.9	13.6	14.0	13.1	12.0	11.0	11.1	8.6	8.0	6.4	6.5	9.7
Helena, Mont	9.2	8.9	8.8	7.9	6.7	6.6	6.6	6.1	5.4	5.4	5.6	6.5	7.2	7.9	8.3	9.4	9.2	10.2	10.4	10.5	9.4	7.3	8.7	8.6	8.0
Huron, S. Dak	9.3	10.1	10.7	11.3	10.5	9.1	9.0	10.5	12.6	13.9	14.0	14.5	15.0	14.4	15.3	14.6	14.2	14.0	13.5	12.4	10.5	9.9	9.9	9.5	12.0
Idaho Falls, Idaho	9.6	8.9	7.7	8.5	8.3	7.8	8.5	8.3	9.0	10.7	11.3	12.0	13.0	14.0	15.0	16.1	15.8	16.1	17.6	17.9	16.6	13.5	10.7	10.1	12.0
Indianapolis, Ind	6.3	6.8	6.7	6.0	5.8	6.1	5.5	6.1	7.3	7.7	8.5	9.2	10.5	11.2	11.1	11.4	11.4	10.8	9.4	8.2	7.3	6.5	7.0	6.4	8.0
Jacksonville, Fla	5.6	5.9	5.7	5.7	5.7	5.7	5.3	5.9	6.4	7.2	7.3	7.9	8.5	9.7	10.3	10.0	10.2	9.1	8.2	6.4	6.3	6.1	5.9	5.5	7.1
Jupiter, Fla	6.2	5.6	5.5	5.3	4.6	4.7	5.0	5.4	6.4	7.4	8.2	9.3	10.0	10.5	10.0	10.7	10.5	9.2	8.7	7.0	6.5	7.0	6.6	6.4	7.4
Kansas City, Mo	6.0	6.1	6.2	6.2	6.5	6.0	6.4	6.7	7.3	8.1	8.7	9.4	9.4	9.8	9.7	9.5	9.5	8.7	8.6	7.5	6.5	6.3	6.8	7.1	7.6
Keokuk, Iowa	5.4	4.7	4.8	5.0	5.1	4.5	4.6	5.4	5.9	6.8	7.2	7.9	7.8	7.8	7.6	7.6	8.0	7.6	7.0	5.5	5.3	5.2	5.5	5.4	6.2
Key West, Fla	6.1	6.1	6.1	5.8	6.0	6.2	6.4	7.0	7.7	7.9	8.3	7.8	7.8	8.5	8.7	9.0	8.7	8.7	8.0	7.6	6.7	6.6	6.5	6.8	7.3
Kittyhawk, N. C	8.2	7.6	7.0	6.3	6.8	6.0	6.6	7.9	9.3	10.2	10.8	10.6	11.1	11.6	12.8	12.4	12.6	11.8	11.7	11.0	10.3	10.8	9.7	9.5	9.7
Knoxville, Tenn	4.2	4.1	4.0	3.4	3.5	2.9	3.3	3.5	4.2	4.5	5.8	6.4	6.4	6.7	7.5	7.4	7.3	6.9	5.8	5.0	4.0	3.5	3.8	3.7	4.9
La Crosse, Wis	4.7	4.5	4.5	4.5	4.4	4.1	4.5	4.4	5.4	6.1	7.0	7.3	7.7	8.7	8.9	8.9	9.3	8.6	8.0	6.3	5.3	4.8	5.0	4.7	6.2
Lander, Wyo	4.2	4.2	4.2	4.2	3.4	3.2	2.9	2.7	2.5	3.2	3.7	4.0	5.5	6.6	7.6	9.8	11.1	10.1	8.1	8.2	7.0	6.6	6.1	4.9	5.6
Lexington, Ky	8.3	7.9	7.9	8.4	8.2	8.2	7.5	8.0	8.4	9.0	9.2	9.7	10.3	10.4	10.8	11.2	11.2	9.6	8.2	7.2	7.4	8.1	8.0	8.1	8.8
Little Rock, Ark	4.5	4.2	3.9	4.0	4.0	4.0	3.8	5.1	7.0	7.8	8.5	8.3	8.8	8.7	9.1	9.7	10.0	10.1	9.2	7.2	5.6	4.9	5.0	5.1	6.6
Los Angeles, Cal	2.5	2.0	1.8	1.9	1.8	1.7	1.5	1.8	1.9	2.2	2.9	3.1	3.8	5.0	6.5	8.1	8.6	8.8	8.5	8.3	7.5	6.4	5.1	3.8	4.4
Louisville, Ky	4.8	4.8	4.3	4.5	4.5	3.8	4.5	5.3	6.5	7.2	8.3	8.4	9.4	9.5	10.3	9.9	9.8	9.7	9.0	6.9	6.1	5.4	5.5	4.9	6.8
Lynchburg, Va	1.9	1.7	1.7	1.5	1.6	1.5	2.1	2.9	3.5	3.9	4.5	4.8	4.8	5.1	5.0	5.2	5.0	4.5	3.9	3.1	2.5	2.6	2.5	2.1	3.3
Marquette, Mich	7.7	7.7	8.1	8.5	7.1	7.5	6.9	7.5	7.2	7.8	8.1	8.4	9.4	9.5	8.6	8.1	8.4	7.0	6.1	5.3	4.5	5.5	7.0	8.1	7.5
Memphis, Tenn	6.6	6.6	7.0	6.8	6.6	6.6	6.4	6.6	6.8	7.0	7.7	8.5	8.6	8.9	9.5	9.2	9.5	8.9	7.2	6.8	5.6	5.8	6.3	6.6	7.3
Milwaukee, Wis	5.6	5.9	6.2	6.4	6.3	6.1	6.2	6.5	7.5	8.5	9.1	9.9	10.9	10.8	10.9	10.7	10.5	9.5	8.5	7.0	6.4	6.0	6.4	5.8	7.8
Mobile, Ala	4.3	4.6	4.8	4.7	4.5	4.4	4.1	4.8	5.5	5.9	6.0	6.9	8.1	9.0	10.5	11.1	11.1	10.8	8.8	6.9	5.4	5.0	4.9	4.5	6.5
Montgomery, Ala	4.5	4.5	4.5	4.1	3.9	3.5	3.5	4.1	4.9	5.4	5.9	6.5	7.0	7.9	8.5	7.8	8.0	7.1	5.7	4.9	5.0	4.8	4.6	4.8	5.5
Moorhead, Minn	7.8	8.4	8.4	8.0	7.5	7.5	7.2	7.7	8.9	10.2	10.7	11.3	10.7	10.2	9.9	10.2	10.5	10.0	9.7	8.7	8.2	8.1	8.0	7.4	9.0
Nantucket, Mass	8.7	8.9	8.7	9.0	8.5	8.8	9.5	10.6	11.6	11.7	12.0	12.0	11.9	12.0	11.5	11.4	11.0	10.8	9.6	9.5	9.6	9.4	8.9	9.0	10.2
Nashville, Tenn	3.3	3.7	3.8	3.7	3.5	3.4	3.1	3.8	4.7	5.7	6.3	7.1	7.3	7.4	7.6	8.2	7.8	8.0	7.3	6.2	5.9	4.7	4.0	3.6	5.4
New Haven, Conn	6.7	6.9	6.6	6.4	6.5	5.8	5.8	7.2	7.6	8.3	8.2	9.0	10.6	10.9	10.3	10.5	10.0	9.0	8.3	8.1	7.8	7.0	6.6	7.0	8.0
New Orleans, La	5.5	5.1	5.0	4.8	5.0	4.8	4.5	5.0	6.5	7.7	7.8	8.1	8.1	8.3	8.8	8.2	8.7	8.9	8.1	6.8	6.5	5.9	5.8	5.7	6.6
New York, N. Y	10.8	9.5	9.4	8.7	8.6	8.5	8.2	7.9	8.1	8.2	8.9	9.4	10.4	11.1	12.9	14.3	13.8	13.1	11.9	11.3	10.9	10.6	10.5	10.6	10.3
Norfolk, Va	5.5	5.6	5.5	4.9	4.6	4.7	5.5	6.2	6.2	6.0	7.1	6.8	8.3	8.6	9.6	9.2	9.2	8.7	7.8	7.3	6.3	6.5	6.2	5.9	6.8
Northfield, Vt	5.0	4.9	5.0	5.0	4.8	4.7	4.4	5.4	6.3	7.7	7.8	7.9	8.4	8.8	7.8	7.3	7.0	7.3	5.5	5.2	6.2	6.3	5.7	5.7	6.3
North Platte, Nebr	8.6	8.7	8.6	8.0	7.5	6.1	5.0	5.5	6.6	8.0	9.5	9.3	9.5	10.5	10.5	11.0	10.9	10.8	10.2	10.4	10.3	9.4	8.9	8.5	8.8
Oklahoma, Okla	8.6	8.8	8.6	7.7	7.5	7.9	7.8	7.9	9.3	10.9	11.9	11.7	11.9	12.4	12.9	12.9	13.1	13.2	12.7	11.2	8.7	8.0	8.3	8.7	10.1
Omaha, Nebr	5.9	5.9	5.5	5.4	5.2	4.9	5.3	6.1	6.7	7.6	8.5	9.2	10.1	10.6	10.7	11.3	11.4	11.0	9.8	8.9	7.1	6.3	6.2	6.0	7.7
Oswego, N. Y	7.8	8.0	8.1	7.9	8.1	8.1	8.3	8.6	8.5	8.6	9.2	8.7	9.0	8.6	8.5	8.4	8.4	7.2	6.5	6.6	6.8	7.0	7.2	7.4	8.0
Palestine, Tex	5.4	5.5	5.5	5.4	5.0	4.7	4.2	4.9	7.2	7.7	7.4	7.2	7.4	7.8	7.9	7.8	7.6	7.1	5.9	5.4	4.5	4.8	5.0	5.4	6.1
Parkersburg, W. Va	3.5	3.1	3.1	3.2	3.5	3.3	3.6	4.1	4.4	4.8	5.4	5.8	5.9	6.6	6.6	6.5	6.7	6.0	5.1	4.6	3.9	3.5	3.2	3.4	4.6

TABLE VII.—*Average wind movement, etc.*—Continued.

Stations.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	Noon.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	Midnight.	Mean.
Pensacola, Fla	5.8	6.0	6.1	6.0	6.1	6.4	5.5	6.2	6.9	7.4	7.7	8.3	9.1	11.7	12.2	12.6	12.5	12.0	11.1	9.5	7.1	6.4	6.0	5.5	8.1
Philadelphia, Pa	6.7	7.2	6.8	6.6	6.8	6.2	7.3	7.9	7.8	8.2	9.1	9.2	9.9	10.5	10.9	11.1	11.4	10.6	8.8	8.1	8.3	7.9	7.7	7.1	8.4
Phœnix, Ariz	4.4	5.0	5.0	4.6	3.7	4.0	3.8	3.4	4.1	4.2	4.4	5.0	5.0	5.1	4.9	5.8	6.4	6.8	6.8	6.5	5.3	4.7	4.8	4.5	4.9
Pierre, S. Dak	8.9	7.2	6.1	6.4	6.7	6.9	6.3	5.7	6.0	7.7	8.9	9.3	9.6	9.9	10.1	10.2	10.9	10.3	10.4	10.3	11.1	11.0	10.0	9.1	8.7
Pittsburg, Pa	3.8	3.6	3.2	3.3	3.5	3.5	3.8	4.6	5.0	5.8	6.5	6.6	7.0	7.6	8.0	7.3	7.6	7.5	6.6	6.1	5.1	4.7	4.6	5.0	5.4
Port Angeles, Wash	7.5	6.4	5.6	5.7	5.2	5.1	5.1	5.1	4.5	3.7	5.1	6.2	7.5	8.4	9.1	9.5	10.7	11.5	12.8	13.9	13.3	11.8	9.1	7.8	7.9
Port Huron, Mich	7.1	6.4	6.8	6.6	6.5	6.6	6.7	7.5	7.5	8.9	9.4	10.1	10.0	11.2	11.6	11.0	10.4	9.9	8.9	6.8	6.2	6.4	6.7	6.9	8.2
Portland, Me	4.3	4.5	4.7	5.1	4.9	5.0	5.1	6.0	6.4	7.6	8.9	10.1	10.3	10.8	10.9	10.6	9.5	8.5	6.9	5.8	5.5	5.1	5.1	4.6	6.9
Portland, Oreg	9.2	8.3	6.7	6.0	5.5	5.0	4.9	4.7	4.7	5.4	7.1	8.4	8.4	7.8	8.3	8.9	9.4	9.1	9.5	11.2	12.0	11.3	10.3	9.8	8.0
Pueblo, Colo	6.3	6.7	6.8	6.3	5.5	4.8	4.3	4.2	3.9	4.0	4.8	5.2	6.7	7.5	8.3	9.4	10.4	10.9	11.3	11.6	10.1	8.3	7.5	7.0	7.2
Raleigh, N. C	3.2	3.7	3.4	3.6	3.5	3.0	3.1	4.0	4.8	5.5	5.3	5.5	5.8	6.4	6.6	6.3	6.0	5.2	4.4	3.7	3.9	3.9	3.8	3.3	4.5
Rapid City, S. Dak	6.2	6.6	6.4	6.2	6.5	6.2	5.6	5.6	5.8	6.3	8.4	9.7	11.7	12.7	12.4	11.7	11.4	10.2	10.0	8.5	7.6	5.7	5.1	5.7	8.0
Redbluff, Cal	7.6	6.8	6.1	5.9	6.0	5.7	5.2	5.7	5.4	5.9	7.2	7.4	7.6	7.0	6.7	6.8	7.1	7.4	7.3	7.2	7.2	7.5	7.2	7.2	6.7
Rochester, N. Y	5.2	5.1	5.3	5.3	5.4	5.5	5.5	5.9	6.2	6.3	6.4	6.9	7.5	7.4	8.0	8.2	8.0	6.7	5.9	5.4	4.8	4.8	4.7	4.9	6.0
Roseburg, Oreg	3.8	2.9	2.5	2.3	2.0	2.1	2.3	2.0	2.3	2.5	3.5	4.4	4.6	5.0	5.9	7.3	7.7	9.2	9.5	10.1	10.5	9.7	7.8	5.4	5.2
Sacramento, Cal	9.5	9.3	9.3	9.4	9.3	9.1	9.3	8.9	8.5	7.6	7.8	7.4	7.9	8.0	8.0	8.5	8.5	8.8	9.5	9.9	9.6	9.6	9.6	9.3	8.9
St. Louis, Mo	7.2	7.1	7.6	6.8	6.9	6.6	6.8	6.6	7.2	8.3	8.8	9.3	9.8	10.3	10.4	10.3	10.3	10.7	9.5	8.5	7.5	7.4	7.0	7.4	8.3
St. Paul, Minn	6.4	6.7	6.0	5.9	5.9	5.4	5.3	6.2	7.1	7.3	7.8	8.4	9.1	9.5	9.9	10.3	10.0	9.2	8.4	7.9	6.9	5.7	5.7	6.2	7.4
Salt Lake City, Utah	5.5	5.0	5.0	5.1	5.1	4.4	4.2	4.5	4.0	3.9	4.7	5.5	7.6	8.6	8.9	8.7	9.4	9.4	8.6	7.7	6.6	6.3	6.7	5.7	6.3
San Antonio, Tex	9.7	8.2	6.6	5.0	5.0	4.3	4.4	4.4	5.6	6.8	7.5	7.4	8.3	9.0	9.8	9.7	10.1	10.7	10.9	11.4	12.2	12.5	12.4	11.2	8.5
San Diego, Cal	3.0	2.7	2.7	2.8	2.8	2.7	3.0	3.1	3.2	3.5	4.2	5.9	7.7	9.1	10.2	10.3	10.7	10.1	9.6	8.9	7.9	6.6	5.5	4.0	5.8
Sandusky, Ohio	5.8	5.6	6.1	5.7	5.3	5.6	5.6	6.1	6.5	7.0	7.7	8.0	8.5	9.0	9.6	9.3	9.3	8.3	7.0	6.3	5.9	5.7	6.3	5.5	6.9
San Francisco, Cal	13.2	11.7	11.5	9.9	9.3	8.7	8.8	8.4	7.6	7.6	8.1	8.2	9.5	12.5	15.9	18.9	21.6	23.6	25.5	25.4	23.7	20.7	18.2	14.5	14.3
San Luis Obispo, Cal	3.1	2.5	2.3	2.3	2.2	2.2	2.8	2.5	2.8	3.0	3.1	3.2	4.3	5.3	6.2	6.6	6.7	6.7	6.4	5.8	5.4	4.3	3.5	3.1	4.1
Santa Fe, N. Mex	5.6	5.9	4.9	4.1	3.2	3.2	3.2	3.5	3.0	3.5	4.1	5.2	6.7	6.4	7.6	8.3	9.2	8.3	8.6	8.7	8.0	6.3	6.1	6.1	5.8
Sault Ste Marie, Mich	4.6	4.8	5.0	4.6	4.5	4.7	5.1	5.5	6.1	7.6	7.9	8.3	9.7	10.5	11.2	11.3	11.0	9.7	8.1	6.6	6.1	5.7	5.3	4.9	7.0
Savannah, Ga	4.8	5.1	4.7	4.4	4.4	4.2	4.9	6.1	6.8	6.5	6.4	7.0	7.9	8.4	9.5	10.0	10.2	9.2	7.8	6.2	5.5	4.7	4.5	4.2	6.4
Seattle, Wash	4.4	3.9	3.7	3.8	3.7	3.5	3.6	3.5	3.4	3.5	4.3	4.5	5.1	5.4	5.9	6.0	6.5	6.3	6.8	7.0	6.9	6.5	5.6	5.2	5.0
Shreveport, La	5.9	5.3	4.7	3.9	4.1	4.0	4.0	4.3	5.7	7.1	6.6	6.1	6.0	6.2	6.1	6.5	6.8	7.1	6.6	6.0	4.9	5.2	5.7	6.0	5.6
Sioux City, Iowa	11.2	10.9	10.2	10.0	9.5	9.3	10.2	10.1	10.9	12.5	13.7	14.7	16.1	16.2	17.0	17.0	16.9	16.0	14.8	13.1	12.4	12.5	11.2	11.3	12.8
Spokane, Wash	4.8	4.1	4.0	4.1	4.8	5.1	5.6	6.2	6.8	7.3	8.2	8.1	8.6	9.4	9.4	9.3	9.8	9.4	9.0	8.6	8.2	6.1	5.4	5.7	7.0
Springfield, Ill	6.9	6.8	6.1	6.0	6.3	5.6	6.1	7.0	7.4	8.1	9.2	9.4	9.4	9.7	9.7	10.0	10.5	9.1	8.1	6.3	5.8	6.3	5.9	6.2	7.6
Springfield, Mo	8.0	7.3	7.4	7.3	7.4	7.6	8.0	7.6	8.4	9.3	10.5	10.6	10.5	9.7	9.7	10.0	9.4	9.7	8.3	7.0	6.7	7.2	7.3	7.5	8.4
Tacoma, Wash	7.0	5.8	4.7	4.5	4.6	4.9	4.2	4.2	3.8	4.5	5.6	6.2	6.9	7.6	7.7	7.9	8.2	8.0	8.5	8.5	8.6	7.8	7.4	7.4	6.4
Tampa, Fla	3.7	3.7	3.6	3.4	3.3	3.0	3.7	4.5	5.4	6.2	6.5	6.2	7.8	8.4	8.5	8.5	8.7	7.4	6.8	5.7	4.4	4.1	3.7	2.9	5.4
Tatoosh Island, Wash	7.6	7.6	7.6	7.8	7.8	7.1	6.8	7.4	7.7	7.8	7.7	7.4	7.6	8.3	8.7	8.7	9.8	9.6	9.0	9.1	8.5	8.5	8.3	7.6	8.1
Toledo, Ohio	6.3	6.3	6.1	5.8	5.9	6.2	6.4	6.5	7.4	7.6	8.6	9.9	10.0	10.2	10.8	10.5	11.0	9.9	8.4	6.7	6.5	6.1	6.0	5.7	7.7
Vicksburg, Miss	4.9	5.4	5.5	5.3	5.6	5.6	5.1	5.4	5.8	5.6	6.0	6.5	6.4	6.9	7.4	7.6	7.2	6.9	6.6	5.8	5.6	5.0	4.7	4.9	5.9
Vineyard Haven, Mass	7.8	7.5	7.4	7.3	7.7	7.7	8.9	9.2	10.2	10.9	10.8	10.6	10.4	10.9	10.8	10.8	10.5	9.7	9.0	8.5	8.1	8.3	8.4	8.2	9.1
Walla Walla, Wash	7.0	7.0	6.5	6.0	6.1	5.8	5.8	5.9	5.7	6.0	7.4	7.7	7.7	7.9	7.5	7.9	8.3	7.8	7.4	7.4	7.0	6.0	5.1	6.0	6.8
Washington, D. C	3.6	3.5	3.5	3.4	3.3	3.8	4.1	5.1	6.0	6.9	6.7	7.4	7.8	8.4	8.0	7.8	7.2	6.5	6.0	4.9	4.5	4.0	4.2	3.8	5.4
Wichita, Kans	6.8	6.5	6.5	5.8	6.1	5.9	5.7	5.9	6.8	8.1	8.5	9.8	10.0	10.6	11.0	10.8	10.7	10.4	10.4	9.5	8.6	8.3	7.6	7.1	8.2
Williston, N. Dak	4.7	4.5	4.6	4.9	5.5	4.5	4.7	4.7	5.0	6.9	9.2	9.5	8.9	10.0	11.4	11.9	11.3	11.3	11.8	12.2	10.0	7.5	7.5	6.3	7.9
Wilmington, N. C	4.6	4.3	4.1	4.2	4.2	4.1	3.9	4.9	5.4	6.0	7.2	8.0	8.9	9.7	10.0	10.0	9.2	8.8	7.8	6.2	5.4	4.9	5.1	4.7	6.3
Woods Hole, Mass	12.2	11.0	11.1	10.2	10.3	10.5	10.9	12.6	13.4	14.2	14.3	13.9	15.1	15.5	16.1	16.1	14.8	14.1	13.0	12.7	12.6	12.6	13.0	12.3	13.0
Yankton, S. Dak	7.0	6.2	5.8	5.8	5.6	5.4	5.7	6.2	7.0	9.3	10.2	11.0	11.6	12.2	13.1	12.7	12.3	11.8	10.3	8.4	6.4	5.9	6.1	6.8	8.4

TABLE VIII.—*Resultant winds from observations at 8 a. m. and 8 p. m., daily, during the month of July, 1897.*

Stations.	Component direction from—				Resultant.	
	N.	S.	E.	W.	Direction from—	Duration.
New England.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	°	*Hours.*
Eastport, Me	10	36	11	9	s. 4 e.	26
Portland, Me	10	29	22	13	s. 25 e.	21
Northfield, Vt	11	45	7	6	s. 2 e.	34
Boston, Mass	11	24	14	25	s. 40 w.	17
Nantucket, Mass	6	36	9	29	s. 34 w.	36
Woods Hole, Mass.*	4	22	6	6	s.	18
Block Island, R. I	7	28	12	36	s. 49 w.	32
New Haven, Conn	14	27	15	22	s. 28 w.	15
Middle Atlantic States.						
Albany, N. Y	10	38	10	9	s. 2 e.	28
Binghamton, N. Y†	6	8	16	8	s. 76 e.	8
New York, N. Y	11	29	15	17	s. 6 w.	18
Harrisburg, Pa	9	23	21	18	s. 12 e.	14
Philadelphia, Pa	11	25	19	20	s. 4 w.	4
Atlantic City, N. J	7	27	19	25	s. 17 w.	21
Baltimore, Md	11	23	19	22	s. 14 w.	12
Washington, D. C	13	29	14	17	s. 11 w.	16
Lynchburg, Va	15	19	18	24	s. 56 w.	7
Norfolk, Va	11	33	21	15	s. 15 e.	23
South Atlantic States.						
Charlotte, N. C	8	33	27	10	s. 34 e.	30
Hatteras, N. C	5	35	16	19	s. 6 w.	30
Kittyhawk, N. C.	12	27	20	16	s. 15 e.	16
Raleigh, N. C	19	22	12	18	s. 63 w.	7
Wilmington, N. C	13	28	17	21	s. 15 w.	16
Charleston, S. C	11	24	15	26	s. 40 w.	17
Augusta, Ga	12	31	17	15	s. 14 e.	8
Savannah, Ga	9	28	14	25	s. 30 w.	22
Jacksonville, Fla	14	25	22	20	s. 10 e.	11
Florida Peninsula.						
Jupiter, Fla	2	36	16	19	s. 5 w.	34
Key West, Fla	4	22	35	15	s. 48 e.	27
Tampa, Fla	14	14	26	21	e.	5
Eastern Gulf States.						
Atlanta, Ga	19	13	15	28	n. 65 w.	14
Pensacola, Fla	18	22	11	32	s. 79 w.	21
Mobile, Ala	25	18	5	25	n. 71 w.	21
Montgomery, Ala	18	23	16	19	s. 31 w.	6
Vicksburg, Miss	12	27	17	23	s. 22 w.	6
New Orleans, La	10	28	11	25	s. 38 w.	23
Western Gulf States.						
Shreveport, La	8	39	13	11	s. 4 e.	31
Fort Smith, Ark	13	15	31	12	s. 84 e.	19
Little Rock, Ark	14	36	13	20	s. 18 w.	23
Corpus Christi, Tex	2	43	28	3	s. 31 e.	48
Galveston, Tex	6	42	15	15	s.	36
Palestine, Tex	9	30	16	10	s. 16 e.	22
San Antonio, Tex	7	36	31	3	s. 44 e.	40
Ohio Valley and Tennessee.						
Chattanooga, Tenn	18	23	11	27	s. 73 w.	17
Knoxville, Tenn	19	14	13	29	n. 73 w.	17
Memphis, Tenn	16	27	12	30	s. 36 w.	14
Nashville, Tenn	13	22	12	32	s. 66 w.	22
Lexington, Ky	9	31	5	32	s. 51 w.	35
Louisville, Ky	13	26	13	21	s. 32 w.	15
Indianapolis, Ind	23	18	9	27	n. 74 w.	19
Cincinnati, Ohio	11	21	12	31	s. 62 w.	22
Columbus, Ohio	15	20	17	24	s. 54 w.	9
Pittsburg, Pa	10	28	14	26	s. 34 w.	22
Parkersburg, W. Va	7	33	18	19	s. 2 w.	26
Lower Lake Region.						
Buffalo, N. Y	10	29	17	24	s. 20 w.	20
Oswego, N. Y	12	29	20	19	s. 3 e	17
Rochester, N. Y	14	27	13	29	s. 51 w.	21
Erie, Pa	12	15	13	22	s. 72 w.	10
Cleveland, Ohio	17	26	15	16	s. 6 w.	9
Sandusky, Ohio	12	24	14	23	s. 37 w.	15
Toledo, Ohio	13	17	13	31	s. 77 w.	18
Detroit, Mich	24	16	20	18	n. 14 e	8
Upper Lake Region.						
Alpena, Mich	23	15	21	18	n. 21 e.	8
Grand Haven, Mich	23	11	16	26	n. 40 w.	16
Marquette, Mich	28	18	10	19	n. 42 w.	14
Port Huron, Mich	29	18	15	12	n. 15 e.	11
Sault Ste. Marie, Mich	13	18	15	27	s. 67 w.	13
Chicago, Ill	27	16	13	16	n. 15 w.	11
Milwaukee, Wis	20	14	22	18	n. 34 e.	7
Upper Lake Region—Cont'd.						
Greenbay, Wis	16	29	15	17	s. 9 w.	13
Duluth, Minn	33	6	19	18	n. 2 e.	27
North Dakota.						
Moorhead, Minn	22	20	23	18	n. 68 e.	5
Bismarck, N. Dak	21	19	19	13	n. 72 e.	6
Williston, N. Dak	28	16	15	19	n. 18 w.	13
Upper Mississippi Valley.						
St. Paul, Minn	14	32	12	18	s. 18 w.	19
La Crosse, Wis. †	6	20	6	6	s.	14
Davenport, Iowa	17	16	21	22	n. 45 w.	1
Des Moines, Iowa	16	24	22	18	s. 27 e.	9
Dubuque, Iowa	12	22	20	21	s. 6 w.	10
Keokuk, Iowa	10	32	15	21	s. 15 w.	23
Cairo, Ill	16	27	14	18	s. 20 w.	12
Springfield, Ill	13	31	11	19	s. 24 w.	20
Hannibal, Mo. †	5	14	9	12	s. 18 w.	10
St. Louis, Mo	15	24	16	18	s. 13 w.	9
Missouri Valley.						
Columbia, Mo.*	6	15	10	9	s. 6 e.	9
Kansas City, Mo	21	25	28	6	s. 80 e.	22
Springfield, Mo	15	31	13	16	s. 9 w.	18
Lincoln, Nebr	18	28	20	9	s. 48 e.	15
Omaha, Nebr	19	27	24	8	s. 63 e.	18
Sioux City, Iowa†	10	14	6	7	s. 14 w.	4
Pierre, S. Dak	24	16	26	10	n. 63 e	18
Huron, S. Dak	26	22	20	14	n. 56 e.	7
Yankton, S. Dak	19	12	19	14	n. 36 e.	9
Northern Slope.						
Havre, Mont	12	17	6	44	s. 83 w.	38
Miles City, Mont	23	17	12	25	n. 65 w.	14
Helena, Mont	9	29	2	39	s. 62 w.	42
Rapid City, S. Dak	20	13	17	29	n. 60 w.	14
Cheyenne, Wyo	28	12	3	30	n. 59 w.	31
Lander, Wyo	15	20	19	27	s. 58 w.	9
North Platte, Nebr	17	23	17	19	s. 18 w.	6
Middle Slope.						
Denver, Colo	15	33	10	13	s. 9 w.	18
Pueblo, Colo	25	12	13	27	n. 47 w.	19
Concordia, Kans	11	37	14	9	s. 11 e.	26
Dodge City, Kans	12	40	10	10	s.	28
Wichita, Kans	16	33	16	9	s. 22 e.	18
Oklahoma, Okla	10	43	14	3	s. 18 e.	35
Southern Slope.						
Abilene, Tex	9	37	20	12	s. 16 e.	29
Amarillo, Tex	9	41	5	14	s. 16 w.	33
Southern Plateau.						
El Paso, Tex	27	5	30	17	n. 30 e.	26
Santa Fe, N. Mex	10	27	31	12	s. 48 e.	26
Phœnix, Ariz	17	8	24	24	n.	9
Yuma, Ariz	10	27	13	27	s. 39 w.	22
Middle Plateau.						
Carson City, Nev	16	15	4	38	n. 88 w.	34
Winnemucca, Nev	11	22	13	34	s. 62 w.	28
Salt Lake City, Utah	17	24	20	16	s. 30 e.	8
Northern Plateau.						
Baker City, Oreg	25	28	5	13	s. 69 w.	8
Idaho Falls, Idaho	15	40	4	9	s. 11 w.	26
Spokane, Wash	6	37	14	19	s. 10 w.	29
Walla Walla, Wash	6	34	4	27	s. 39 w.	36
North Pacific Coast Region.						
Fort Canby, Wash	37	7	2	24	n. 36 w.	37
Port Angeles, Wash.*	10	1	1	25	n 69 w.	26
Seattle, Wash	23	22	9	18	n. 84 w.	9
Tacoma, Wash.	20	21	2	30	s. 88 w.	28
Tatoosh Island, Wash	0	46	2	23	s. 25 w.	51
Portland, Oreg	35	10	7	35	n. 49 w.	38
Roseburg, Oreg	43	2	22	16	n. 9 e.	41
Middle Pacific Coast Region.						
Eureka, Cal	28	15	2	36	n. 69 w.	36
Redbluff, Cal	31	15	13	17	n. 14 w.	16
Sacramento, Cal	17	34	1	25	s. 55 w.	29
San Francisco, Cal	0	21	0	54	s. 68 w.	58
South Pacific Coast Region.						
Fresno, Cal	37	3	2	41	n. 49 w.	52
Los Angeles, Cal	6	19	12	27	s. 49 w.	20
San Diego, Cal	24	14	5	37	n. 73 w.	34
San Luis Obispo, Cal	19	19	2	30	w.	28

* From observations at 8 p. m. only. † From observations at 8 a. m. only.

TABLE IX.—*Thunderstorms and auroras, July, 1897.*

States.	No. of stations.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total. No.	Total. Days.	
Alabama	52	T.	4	6	5	8	5	4	3	3	7	6	3				2	6	2	7	8	4	5	2		2	1	6	2					101	23	T.
		A.																																0	0	A.
Arizona	52	T.	2						4	8	3	7	7			1	2	2	3	5			1	5	1		1		5	4	5	2	3	71	20	T.
		A.																																0	0	A.
Arkansas	61	T.	1			1	3	8	13	7	11	13	1			1	1	3	4	7	10	12	4			3	4	7	1	1	3		1	120	24	T.
		A.																																0	0	A.
California	181	T.												7	4								3						1					15	4	T.
		A.																																0	0	A.
Colorado	75	T.	4	8	3	1		1	2	10	10		1	1		10	1	4	13	12	8	1	1	5	4	11	1	6	7	1	1	4	7	138	28	T.
		A.																																0	0	A.
Connecticut	14	T.		7	1			3	2					2		4						4	1	5	8	4	1			3	5		7	57	15	T.
		A.																															1	1	1	A.
Delaware	3	T.			3				2				2	1	1	1			1	1													1	13	9	T.
		A.																																0	0	A.
Dist. of Columbia	4	T.							1				1	1					1	1	1				1								1	8	8	T.
		A.																																0	0	A.
Florida	45	T.	3	10	7	3	10	6	7	6	3	9	7	6	2	1		1	3	5	1	2	4	7	9	7	6	7	7	7	7	7	9	169	30	T.
		A.																																0	0	A.
Georgia	62	T.	2	6	5	7	7	6	1	5	5	3	3	2	1			7	7	4	8	6	7	2	1	2	5	5	2	1				110	26	T.
		A.																																0	0	A.
Idaho	30	T.	5	3	1				2								2	5	5	1		1	2	5	2	1					2	2		39	15	T.
		A.																					1											1	1	A.
Illinois	92	T.	7	21	3	13	8	1	2	4	15	32	12	6		2	13	8	2	1	4	15	1		13	19	19	6				16	2	245	26	T.
		A.																					3			1						2	1	7	4	A.
Indiana	54	T.	2			1	8		1	2	11	13	3	1	4	1	1	8	3	4	3	4	1		1	4	4					3	13	96	23	T.
		A.																					1											1	1	A.
Indian Territory	7	T.					1												1	1	1	2												6	5	T.
		A.																																0	0	A.
Iowa	122	T.	2	10	10	14	4				24	20	7		1	4			3	1	2	17	1		33	13	6				5	17	9	203	21	T.
		A.																				1	7								1	1	1	11	5	A.
Kansas	85	T.	1	3	7	13	1	1			5	7		1				1	3	7	6	3		1	2	12	8	2	4	7				95	21	T.
		A.																				2												2	1	A.
Kentucky	52	T.	6	10	3	3	10	2	2		9	11	5	1	2		5	7	3	3	2	3		1	1	10	5	3				1	7	115	25	T.
		A.																																0	0	A.
Louisiana	50	T.	4		4	6	6	4	6	6	6	9	9	2			1		5	6	6	6	7	7	2	2	1		7	2				114	23	T.
		A.																																0	0	A.
Maine	14	T.		1				1			1			2		1			5			1	2	2	4	1						2	7	30	13	T.
		A.																														2		2	1	A.
Maryland	35	T.	2	3		1	2	2	15			1	10	10	2	6			9	8	10	6	4	1	11	5	1	4	4	1			10	128	24	T.
		A.																																0	0	A.
Massachusetts	24	T.		5							1								1	3				2	2	7					8		5	34	9	T.
		A.																					2									2	1	5	3	A.
Michigan	112	T.	3	5	2		6			3	11	16	7	6	13	4	1	14	5	3	1	4	4	2			1	10		2	6	6	1	136	26	T.
		A.				1																1	7			1					3	9		22	6	A.
Minnesota	69	T.	7	19	19	5	16	20	16	5	12	2	3		1	10				5	4	13	2	2	13	3	12	5		3	14	10	15	236	26	T.
		A.									1																						2	3	2	A.
Mississippi	46	T.	2	1		6	9	8	7	7	12	11	10	2				2	3	10	8	6	6	3	1		1	5	4					124	22	T.
		A.																																0	0	A.
Missouri	95	T.	20	3	5	24	4		4	1	16	27	5	1		3	11	4	17	4	7	12	1		4	24	27	2		7	2	1		236	26	T.
		A.																					1										1	2	2	A.
Montana	37	T.	2		1	1			2									3	1	2			2	2						1		4		21	11	T.
		A.																															2	2	1	A.
Nebraska	143	T.	1	8	7	3	3	2		2	17	7	4			1		2	2	2	8	3	1	2	2	2	1	12	6	1	2			101	26	T.
		A.																					4	2								2		8	3	A.
Nevada	48	T.		1									1	5	10	8	6	3	1		1	2	5	8	4		2	1		4	2	3		67	18	T.
		A.																																0	0	A.
New Hampshire	14	T.		1				8	3	1				5	1	3	1		5	2	1	2	2	2	8	4	1						7	57	18	T.
		A.																																0	0	A.
New Jersey	55	T.		17	1			7	7				16	19	2	20				18	7	9	18	1	27	8	12			17	2	5	10	223	20	T.
		A.																														2		2	1	A.
New Mexico	39	T.	1					1	1	3	2	1	2	1			4	4	1				1	4					2	2	1	1	4	36	18	T.
		A.																															1	1	1	A.
New York	103	T.		7		2	11	14	6	1	2	11	23	9	2	23	1	2	11	16	11	18	6	8	23	1	10	3	1	4	1	9	4	240	29	T.
		A.									1												2	1								2	1	7	5	A.
North Carolina	59	T.	9	8	8	11	4	7	15	15	14	12	11	14	6	3		4	8	7	12	11	9	1	2	8	6	10	3	1	1		1	221	29	T.
		A.																																0	0	A.
North Dakota	46	T.	4	8	5	1	2	5	6	4		1				2		6	6	4	3			2	6	1	4	1		2	1		1	75	22	T.
		A.																					1									1		2	2	A.
Ohio	135	T.	15	8	3	12	45	2	4	8	7	21	42	23	13	19	1	19	27	30	35	20	11	18	10	6	3	16	4	4	2	1	10	439	31	T.
		A.	1			1								1									12	1								1		17	6	A.
Oklahoma	23	T.		1	1		3											1		2	4					1	1							14	8	T.
		A.																																0	0	A.
Oregon	62	T.	1												2							1	2											6	4	T.
		A.																																0	0	A.
Pennsylvania	105	T.	14	5	1		10	20	13	3			31	12		17	2	4	14	26	17	13	16	15	24	1	11	5	4	1		11	9	299	26	T.
		A.																																0	0	A.
Rhode Island	5	T.	1																							2							2	5	3	T.
		A.																																0	0	A.
South Carolina	43	T.	3	6	6	10	2	1	1	6	4	8	7	11	3				10	4	13	10	8	3			6	13	6		1	1		143	24	T.
		A.																																0	0	A.
South Dakota	44	T.	3	3	4	4	3	2		3	4				1	6	1	2	3	3	5	3		2	1	4		4	2		3	4	1	71	24	T.
		A.																	2				3									1		6	3	A.
Tennessee	65	T.	4	7	3	9	8	9	5	7	13	15	7	3	2	2	6	14	5	8	6	11	6	1	1	8	11	8					1	180	27	T.
		A.																										1						1	1	A.
Texas	85	T.						6	6	4	2	7	5			1			5	3	2	1	4	4	2			3	7	5	1			68	18	T.
		A.																																0	0	A.
Utah	41	T.		5	1					1	1			1	1	5	4	7	2					6	6	1	2				1	6	1	51	17	T.
		A.																																0	0	A.
Vermont	13	T.		3			2	8	5	3		1	3	4	1	3			5	2	1	6	5	2	8	4						2	2	70	20	T.
		A.																														1		1	1	A.
Virginia	49	T.	7			2	1	7	10	4	2	7	10	3	4	3			8	6	4		2	1	8	2		1	6	6			1	105	23	T.
		A.																																0	0	A.
Washington	50	T.	2						2										1												1			6	4	T.
		A.																														3		3	1	A.
West Virginia	35	T.	6	2	1	5	6	6	7	4		4	8	1		2		2	7	8	5	2	3	1	7	2	1	2	1	2			2	97	26	T.
		A.																																0	0	A.
Wisconsin	61	T.	3	8	5	7	4	1	1	1	18	12	16	5			2	5				4	1	1		1	7	1	1	1	3	3	2	113	25	T.
		A.																				1	7	1								10		19	4	A.
Wyoming	14	T.		2		1		1			1				1	2	3	2	2	1		1	1	1	1	2	1					4	2	29	22	T.
		A.																																0	0	A.
Sums	2,810	T.	153	221	125	174	204	174	184	137	249	294	282	166	81	169	71	132	223	243	225	239	160	137	254	188	183	148	87	90	80	125	158	5,376	....	T.
		A.	1	0	0	2	0	0	0	0	2	0	0	1	0	0	0	0	2	0	0	5	51	5	0	2	0	1	0	0	4	39	11	126	....	A.

TABLE X.—*Hourly sunshine as deduced from sunshine recorders, July, 1897.*

Stations.	Instrument.	Percentages for each hour of local mean time ending with the respective hour.																Hours of sunshine.			
		A. M.								P. M.								Total.			Personal estimate.
		5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	Actual.	Possible.	Percent of possible.	
																		Hours.	*Hours.*		
Albany, N. Y	T.	36	32	45	64	79	92	89	92	94	94	83	70	59	46	38	43	315.5	465.2	68	41
Atlanta, Ga	T.	50	41	45	43	47	49	56	62	61	60	47	45	43	35	34	23	208.6	439.7	47	37
Atlantic City, N. J	P.	71	65	64	63	63	64	66	70	69	67	71	65	63	57	39	34	283.8	453.0	63	46
Baltimore, Md	T.	26	29	30	39	55	62	61	58	54	53	39	38	33	20	19	21	187.1	453.0	41	44
Binghamton, N. Y	T.	38	31	34	44	50	57	69	66	66	69	69	64	55	42	32	29	240.5	461.8	52	37
Bismarck, N. Dak	P.	46	51	50	61	64	66	67	67	69	66	63	57	54	51	47	36	277.1	479.6	58	56
Boston, Mass	T.	38	43	45	48	45	56	60	58	65	61	53	53	42	34	24	16	219.7	461.8	48	35
Buffalo, N. Y.	T.	37	36	47	59	71	77	83	86	84	85	85	77	69	55	43	36	308.3	465.2	66	35
Charleston, S. C.	T.	57	58	60	64	77	85	82	81	81	75	75	62	49	38	26	27	283.5	437.2	65	51
Chattanooga, Tenn	T.	38	38	46	54	55	69	65	69	61	57	54	53	53	39	37	34	235.8	442.0	53	46
Cheyenne, Wyo	P.	67	72	75	75	77	80	83	77	72	65	54	56	57	50	40	36	300.9	458.6	66	56
Chicago, Ill	T.	21	20	40	51	73	79	79	82	79	77	71	72	58	40	27	32	270.8	461.8	59	59
Cincinnati, Ohio	T.	40	33	38	60	78	85	87	90	90	92	92	94	82	75	65	53	337.8	453.0	75	61
Cleveland, Ohio	T.	25	24	31	48	59	73	73	75	76	71	73	71	68	59	52	49	275.5	461.8	60	52
Columbus, Ohio	T.	54	55	63	65	75	83	90	93	90	92	86	79	74	70	60	53	344.4	455.2	76	52
Denver, Colo	P.	76	73	76	73	78	76	86	76	72	75	67	63	62	56	47	61	318.0	455.2	70	50
Des Moines, Iowa	T.	62	66	63	64	68	68	75	78	79	78	72	70	65	72	75	67	326.1	461.8	71	69
Detroit, Mich	T.	54	56	71	77	80	84	90	87	84	83	82	79	78	71	58	55	349.8	461.8	76	62
Dodge City, Kans	P.	69	75	85	90	91	88	88	89	87	89	87	86	79	76	68	65	376.2	450.1	84	73
Dubuque, Iowa	T.	62	57	59	67	73	83	85	83	83	76	78	78	69	64	68	68	336.1	461.8	73	69
Eastport, Me	P.	26	29	32	38	46	52	55	61	54	60	56	58	52	45	40	35	221.5	471.7	47	30
Erie, Pa	T.	52	48	46	50	63	78	70	73	75	71	63	58	55	52	50	49	278.7	461.8	60	46
Eureka, Cal	P.	8	14	23	29	41	47	62	71	82	83	86	85	82	78	50	31	266.4	458.6	58	61
Fresno, Cal	T.	84	81	84	91	98	99	100	100	97	97	96	95	96	95	94	96	422.2	447.4	94	91
Galveston, Tex	P.	......	46	78	90	93	92	93	95	94	99	99	100	96	88	57	75	375.1	427.4	88	79
Harrisburg, Pa	T.	49	49	53	63	70	75	78	80	77	73	65	60	59	51	39	35	284.6	455.2	63	41
Helena, Mont	P.	57	64	76	71	69	73	77	73	68	63	66	58	59	63	62	47	316.1	479.6	66	56
Idaho Falls, Idaho	T.	33	35	38	53	75	85	86	85	85	79	76	73	61	64	49	46	305.3	465.2	66	63
Indianapolis, Ind	T.	61	57	72	83	83	91	90	91	86	94	91	84	82	81	64	38	365.9	455.2	80	58
Kansas City, Mo	P.	54	55	72	78	77	78	84	85	79	76	79	81	77	76	75	86	346.1	453.0	76	67
Key West, Fla	T.	......	34	45	62	71	78	83	85	79	86	83	79	65	42	32	.....	281.5	419.1	67	40
Little Rock, Ark	T.	90	79	80	82	84	88	84	86	94	100	93	86	79	66	55	51	363.4	442.0	82	56
Los Angeles, Cal	P.	8	17	17	34	53	75	85	93	94	96	99	100	100	99	94	93	331.7	439.7	75	65
Louisville, Ky	T.	76	70	69	68	66	70	78	83	84	89	85	82	62	63	54	59	327.9	450.1	73	49
Minneapolis, Minn	T.	22	29	35	41	47	54	58	61	66	63	58	50	46	35	25	23	215.5	471.7	46	......
Nashville, Tenn	T.	68	62	70	71	71	74	79	84	84	80	78	70	62	49	43	24	306.3	444.3	69	55
New Orleans, La	T.	......	37	41	52	62	56	54	60	52	53	51	50	41	23	15	18	199.0	429.6	46	45
New York, N. Y	T.	4	11	23	34	53	68	73	71	70	72	70	65	54	42	21	15	227.3	458.6	50	37
Northfield, Vt	P.	10	22	39	45	51	55	55	50	48	50	53	57	54	46	23	24	207.0	468.4	44	31
Omaha, Nebr	P.	61	57	63	72	77	80	90	89	91	90	87	86	85	71	58	59	354.9	458.6	77	66
Philadelphia, Pa	T.	28	29	42	45	59	64	72	76	73	69	61	55	57	40	40	33	248.9	455.2	55	32
Phœnix, Ariz	P.	71	63	86	85	93	91	89	92	94	94	97	93	92	84	65	61	379.7	437.2	87	79
Pittsburg, Pa.	T.	27	26	27	37	64	71	81	74	81	75	67	58	49	29	19	17	240.1	458.6	52	48
Portland, Me	T.	0	1	15	31	47	59	67	77	77	73	73	60	47	37	8	0	208.6	468.4	45	31
Portland, Oreg.	T.	48	52	51	55	66	68	73	75	84	88	83	77	70	67	71	73	329.3	475.7	69	66
Portland, Oreg.	P.	48	53	54	55	62	64	63	65	72	77	73	73	72	72	71	73	313.0	475.7	66	66
Raleigh, N. C	T.	35	36	45	65	84	91	94	96	93	87	82	79	68	55	44	37	319.4	444.3	72	36
Rochester, N. Y.	T.	45	39	45	44	48	61	66	70	68	64	62	56	54	38	38	20	243.0	465.2	52	47
St. Louis, Mo.	T.	71	72	74	78	79	81	85	92	90	90	89	88	86	77	67	63	367.6	453.0	81	60
St. Paul, Minn	P.	41	50	60	66	66	63	58	62	65	67	73	79	69	58	53	53	293.3	471.7	62	47
Salt Lake City, Utah	P.	72	73	78	83	85	85	89	87	81	81	87	91	84	78	71	75	375.6	458.6	82	62
San Diego, Cal	P.	14	14	9	27	64	81	93	99	99	99	96	96	94	92	87	89	329.5	437.2	75	81
San Francisco, Cal.	T.	11	11	45	58	66	82	96	99	99	100	100	100	96	78	39	32	335.6	450.1	74	70
Santa Fe, N. Mex	P.	58	60	77	81	77	80	81	77	68	66	56	53	52	57	40	28	290.9	444.3	65	56
Savannah, Ga	P.	33	57	69	81	84	83	80	79	78	74	69	67	59	54	44	40	303.0	434.5	70	48
Seattle, Wash	T.	32	35	39	47	62	62	72	84	92	87	82	82	74	62	54	53	310.5	483.2	64	59
Spokane, Wash	T.	45	63	67	73	77	84	85	91	88	88	91	93	82	80	76	56	377.6	483.2	78	55
Tampa, Fla	T.	......	68	68	64	62	69	64	68	61	55	54	43	35	29	29	......	233.4	424.9	55	52
Vicksburg, Miss.	T.	67	46	75	93	100	100	100	97	94	96	96	88	81	79	52	41	370.8	434.5	85	62
Washington, D. C	P.	46	52	55	61	67	66	71	66	74	73	65	58	60	56	51	55	280.9	453.0	62	50
Wilmington, N. C	T.	50	28	35	55	72	69	65	63	61	58	53	52	51	38	29	32	227.6	439.7	52	42

TABLE XI.—*Accumulated amounts of precipitation for each 5 minutes, for storms in which the rate of fall equaled or exceeded 0.25 in any 5 minutes, or 0.75 in 1 hour during July, 1897, at all stations furnished with self-registering gauges.*

Station.	Date.	Total duration. From—	Total duration. To—	Total am't of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
Albany, N. Y.	13-14	4.30 p.m.	8.01 a.m.	2.34	12.55 a.m.	2.55 a.m.	0.50	0.03	0.07	0.13	0.16	0.19	0.22	0.27	0.32	0.37	0.40	0.45	0.66	0.96	1.20
Atlanta, Ga.	19	7.33 a.m.	3.45 p.m.	2.21	10.48 a.m.	11.28 a.m.	0.02	0.25	0.52	0.89	1.16	1.58	1.68	1.76							
Atlantic City, N. J.	13-14	1.45 p.m.	1.00 a.m.	2.12	5.25 p.m.	6.15 p.m.	0.60	0.04	0.10	0.15	0.20	0.25	0.33	0.45	0.63	0.75	0.79				
Do	23	6.10 p.m.	9.30 p.m.	0.88	7.24 p.m.	7.46 p.m.	T.	0.30	0.46	0.48	0.55	0.67									
Baltimore, Md.	17	12.25 p.m.	5.40 p.m.	1.76	3.28 p.m.	3.48 p.m.	0.38	0.26	0.66	1.05	1.17										
Binghamton, N. Y.	28			0.22											0.22						
Bismarck, N. Dak.	25	4.43 p.m.	5.35 p.m.	0.59	5.00 p.m.	5.25 p.m.	0.04	0.06	0.15	0.21	0.39	0.53									
Boston, Mass.	29	D. N.	10.05 a.m.	1.48	6.27 a.m.	8.27 a.m.	0.16	0.30	0.39	0.45	0.49	0.52	0.62	0.68	0.77	0.78	0.99	1.04	1.12	1.17	1.22
Buffalo, N. Y.	11	5.05 p.m.	7.45 p.m.	1.88	5.05 p.m.	5.50 p.m.	0.00	0.20	0.45	0.70	0.85	1.00	1.20	1.50	1.57	1.62					
Do	23	5.47 a.m.	9.10 a.m.	0.67	5.47 a.m.	6.07 a.m.	0.00	0.20	0.42	0.59	0.67										
Chicago, Ill	4	12.08 p.m.	1.00 p.m.	0.42	12.10 p.m.	12.25 p.m.	T.	0.05	0.20	0.37											
Cincinnati, Ohio	5	4.20 p.m.	5.58 p.m.	2.20	4.32 p.m.	5.32 p.m.	0.01	0.11	0.31	0.51	0.73	1.05	1.32	1.55	1.67	1.79	1.94	2.10	2.18		
Cleveland, Ohio	5			0.65														0.33			
Columbus, Ohio	11	3.55 p.m.	8.04 p.m.	3.81	4.03 p.m.	4.50 p.m.	0.01	0.20	0.28	0.40	0.65	1.05	1.35	1.65	2.00	2.45	2.62	2.79	2.80	2.86	2.93
Denver, Colo	9-10			0.78														0.23			
Des Moines, Iowa	9	3.32 p.m.	8.00 p.m.	0.57	3.32 p.m.	4.00 p.m.	0.00	0.15	0.37	0.40	0.42	0.50	0.52								
Do	23-24	10.55 p.m.	1.25 a.m.	1.05	10.55 p.m.	11.20 p.m.	0.00	0.11	0.29	0.57	0.79	0.86									
Detroit, Mich	16			0.29								0.25									
Dodge City, Kans.	19	4.02 p.m.	5.40 p.m.	1.70	4.02 p.m.	4.38 p.m.	0.00	0.10	0.29	0.53	0.72	0.90	1.15	1.47	1.57						
Do	19-20	10.28 p.m.	1.15 a.m.	1.78	11.01 p.m.	11.40 p.m.	0.05	0.06	0.22	0.37	0.59	0.75	0.97	1.15	1.30	1.36					
Duluth, Minn *	2-3	12.45 p.m.	8.45 a.m.	4.09	2.35 a.m.	†															1.45†
Do	9	D. N.	7.35 a.m.	0.69	6.37 a.m.	6.58 a.m.	0.05	0.13	0.25	0.36	0.43	0.47	0.50								
Eastport, Me	24			0.65														0.52			
Erie, Pa	26			0.50														0.44			
Galveston, Tex	27	7.29 p.m.	9.45 p.m.	0.77	7.42 p.m.	8.10 p.m.	0.01	0.20	0.40	0.50	0.58	0.65	0.69								
Harrisburg, Pa	26-27			1.55														0.46			
Hatteras, N. C.	12-13	9.30 a.m.	5.40 p.m.	5.57	8.00 a.m. 8.50 a.m. 9.40 a.m.	8.50 a.m. 9.40 a.m. 11.00 a.m.	1.37	0.06 1.17 2.05	0.15 1.25 2.24	0.23 1.42 2.47	0.40 1.53 2.74	0.53 1.62 2.93	0.60 1.73 2.97	0.72 1.77 3.09	0.87 1.79 3.27	0.98 1.81 3.35	1.12 1.91 3.40	 3.59	 3.77		
Indianapolis, Ind	11	9.55 a.m.	1.45 p.m.	1.50	12.17 p.m.	12.57 p.m.	0.05	0.10	0.25	0.40	0.54	0.65	0.84	1.00	1.08						
Do	25	6.10 p.m.	9.10 p.m.	1.50	7.25 p.m.	8.00 p.m.	0.08	0.05	0.10	0.35	0.70	1.05	1.32	1.42							
Jacksonville, Fla †	5			1.85														0.95			
Jupiter, Fla	9	3.40 a.m.	10.00 a.m.	1.25	5.25 a.m.	5.50 a.m.	0.15	0.05	0.20	0.34	0.52	0.64	0.67	0.69	0.75	0.79	0.90				
Do	29	5.25 p.m.	6.10 p.m.	0.98	5.25 p.m.	5.50 p.m.	0.00	0.05	0.14	0.43	0.80	0.93	0.96								
Kansas City, Mo	1	D. N.	9.40 a.m.	1.79	12.45 a.m.	2.42 a.m.	0.08	0.15	0.30	0.34	0.36	0.38	0.43	0.48	0.53	0.54	0.59	0.77	0.98	1.17	1.48
Key West, Fla	31	9.08 p.m.	10.15 p.m.	0.83	9.25 p.m.	9.45 p.m.	0.10	0.15	0.42	0.60	0.66	0.69									
Do	31	11.20 p.m.	D. N.	0.74	11.25 p.m.	11.45 p.m.	0.04	0.04	0.30	0.47	0.65	0.70									
Lincoln, Nebr	9-10			1.78														0.33			
Little Rock, Ark	20			0.50										0.35							
Louisville, Ky	10	12.55 p.m.	3.12 p.m.	1.65	1.15 p.m.	2.00 p.m.	0.04	0.05	0.15	0.20	0.40	0.72	0.97	1.11	1.23	1.28	1.31	1.39	1.60		
Do	11	4.04 p.m.	7.10 p.m.	1.02	5.30 p.m.	5.50 p.m.	0.05	0.20	0.45	0.72	0.81	0.83									
Do	24	11.40 a.m.	12.45 p.m.	0.92	12.05 p.m.	12.35 p.m.	T.	0.30	0.47	0.52	0.74	0.86	0.90								
Memphis, Tenn.	21	2.45 a.m.	3.10 a.m.	0.47	2.47 a.m.	3.00 a.m.	T.	0.25	0.43	0.46											
Milwaukee, Wis.	10			0.37								0.37									
Montgomery, Ala.	9	4.52 p.m.	6.35 p.m.	0.80	4.54 p.m.	5.47 p.m.	T.	0.13	0.25	0.33	0.34	0.35	0.36	0.42	0.53	0.60	0.68	0.76			
Nantucket, Mass.	29			0.61								1.05	1.37	1.59	1.70			0.50			
Nashville, Tenn.	4	6.24 p.m.	9.15 p.m.	1.95	8.20 p.m.	9.00 p.m.	0.20	0.15	0.35	0.57	0.80										
Do	10	5.40 p.m.	9.30 p.m.	1.20	5.40 p.m.	6.00 p.m.	0.00	0.17	0.67	0.95	1.02										
Do	11	6.38 p.m.	7.25 p.m.	1.30	6.40 p.m.	7.20 p.m.	T.	0.10	0.23	0.41	0.72	0.98	1.09	1.18	1.26						
New Orleans, La.	17	12.25 p.m.	1.50 p.m.	1.35	12.36 p.m.	1.20 p.m.	T.	0.20	0.49	0.60	0.78	0.87	1.05	1.19	1.25	1.30					
New York, N. Y.	18	7.55 a.m.	2.20 p.m.	0.99	8.02 a.m.	9.00 a.m.	0.07	0.06	0.11	0.19	0.33	0.53	0.65	0.73	0.77						
Do	23	3.36 p.m.	7.20 p.m.	0.84	3.50 p.m.	4.25 p.m.	0.05	0.25	0.40	0.52	0.63	0.64	0.68	0.73							
Norfolk, Va.	27	7.00 p.m.	7.30 p.m.	0.79	7.03 p.m.	7.22 p.m.	T.	0.20	0.48	0.70	0.76										
Do	28	7.20 p.m.	8.03 p.m.	0.78	7.31 p.m.	7.46 p.m.	0.02	0.30	0.55	0.75											
Northfield, Vt	6	4.35 p.m.	8.20 p.m.	2.05	5.08 p.m.	5.37 p.m.	0.08	0.15	0.32	0.49	0.80	1.15	1.26	1.28	1.38	1.45	1.55				
Oklahoma, Okla.	20	12.01 a.m.	D. N.	1.48	12.05 a.m.	1.05 a.m.	0.03	0.07	0.34	0.47	0.50	0.60	0.73	0.76	0.94	1.09	1.17	1.24			
Omaha, Nebr	9-10	3.42 p.m.	D. N.	1.03	3.45 p.m.	4.20 p.m.	T.	0.06	0.16	0.30	0.46	0.60	0.65	0.68	0.70						
Parkersburg, W. Va.	17	5.20 a.m.	6.10 a.m.	0.46	5.32 a.m.	5.41 a.m.	0.01	0.30	0.36	0.38	0.44										
Do	26-27	7.25 p.m.	D. N.	1.10	7.50 p.m.	8.17 p.m.	0.05	0.09	0.11	0.24	0.31	0.47	0.54								
Philadelphia, Pa.	27-28			2.14														0.45			
Pittsburg, Pa	11	3.00 p.m.	6.00 p.m.	0.83	3.33 p.m.	4.00 p.m.	0.07	0.10	0.19	0.40	0.52	0.60	0.62								
Do	18	5.55 p.m.	7.25 p.m.	0.76	6.00 p.m.	6.30 p.m.	T.	0.04	0.14	0.29	0.49	0.56	0.60	0.62							
Portland, Me.	22			0.56														0.21			
Portland, Oreg.	5			0.16											0.16						
Raleigh, N. C	12	4.20 p.m.	9.00 p.m.	1.25	5.40 p.m.	6.25 p.m.	0.01	0.21	0.37	0.49	0.58	0.65	0.73	0.76	0.81	0.95					
Rochester, N. Y.	11	3.30 p.m.	9.40 p.m.	3.37	4.05 p.m.	5.15 p.m.	0.03	0.14	0.44	0.71	1.06	1.36	1.70	1.84	1.96	2.12	2.24	2.49	2.74		
St. Louis, Mo.	25			0.96														0.29			
St. Paul, Minn.	3	4.40 a.m.	6.25 a.m.	0.64	5.55 a.m.	6.15 a.m.	0.08	0.08	0.30	0.43	0.52	0.54									
Do	5	8.05 p.m.	11.55 p.m.	0.93	10.50 p.m.	11.40 p.m.	0.11	0.05	0.11	0.29	0.49	0.64	0.66	0.69	0.74	0.80	0.83				
Do	25	2.44 p.m.	3.55 p.m.	1.53	2.50 p.m.	3.40 p.m.	T.	0.26	0.27	0.44	0.70	0.78	0.91	0.98	1.31	1.46	1.51				
Salt Lake City, Utah	30			0.05																	
San Diego, Cal	3			0.01																	
San Francisco, Cal.	22			T.																	
Savannah, Ga	5	11.20 a.m.	11.59 a.m.	1.00	11.20 a.m.	11.59 a.m.	0.00	0.10	0.26	0.37	0.44	0.59	0.73	0.83	1.00						
Do	11	2.25 p.m.	3.20 p.m.	1.47	2.32 p.m.	2.52 p.m.	T.	0.65	1.08	1.32	1.43	1.45									
Do	22	11.28 a.m.	1.15 p.m.	2.00	11.33 a.m.	12.35 a.m.	0.01	0.05	0.19	0.39	0.52	0.64	0.79	1.01	1.29	1.49	1.69	1.84			
Seattle, Wash.	5			1.00														0.22			
Tampa, Fla.	11-12	D. N.	4.40 p.m.	2.94	8.00 a.m.	9.05 a.m.	0.74	0.10	0.17	0.21	0.23	0.26	0.34	0.41	0.54	0.65	0.75	0.95			
Vicksburg, Miss.	10	7.48 p.m.	8.50 p.m.	1.70	7.58 p.m.	8.40 p.m.	0.03	0.24	0.44	0.62	0.82	1.00	1.25	1.46	1.60	1.65					
Do	18	2.30 p.m.	6.30 p.m.	1.81	3.27 p.m.	3.47 p.m.	0.03	0.16	0.36	0.89	1.23										
Do	20	8.26 p.m.	9.30 p.m.	1.52	8.28 p.m.	9.10 p.m.	0.01	0.15	0.39	0.66	0.90	1.05	1.26	1.42	1.50	1.52					
Washington, D. C	7	3.00 p.m.	3.48 p.m.	0.83	3.00 p.m.	3.48 p.m.	0.00	0.06	0.09	0.40	0.50	0.56	0.56	0.70	0.82	0.83					
Do	21-22	11.20 p.m.	3.40 a.m.	1.13	2.37 a.m.	3.17 a.m.	0.53	0.23	0.38	0.39	0.40	0.45	0.55	0.58	0.60						
Wilmington, N. C	25	1.05 p.m.	3.50 p.m.	2.60	1.52 p.m.	2.50 p.m.	0.32	0.38	0.83	1.23	1.49	1.55	1.58	1.87	2.03	2.06	2.14	2.25			
Yankton, S. Dak	9-10			2.06														0.33			

* Self register out of order during heavy rain of the 3d. Estimated that 1.45 inches fell in 2 hours. † Record incomplete.

TABLE XII.—*Excessive precipitation, by stations, for July*, 1897.

Stations.	Monthly rainfall 10 inches, or more.	Rainfall 2.50 inches, or more, in 24 hours.		Rainfall of 1 inch, or more, in one hour.		
		Amt.	Day.	Amt.	Time.	Day.
Alabama.	Inches.	Inches.		Ins.	h.m.	
Birmingham		2.95	19			
Brewton				1.50	1 00	5
Do				2.35	1 00	26
Demopolis				1.54	1 30	20
Greensboro		2.97	19			
Madison		2.50	18-19			
Mobile		2.63	26-27			
Newton	10.49	6.20	2	6.20	2 00	2
Do				1.49	1 00	22
Tuscaloosa		3.39	18-19			
Union		4.65	18-19			
Wilsonville				1.06	1 00	2
Arizona.						
Payson				1.00	1 00	30
Tucson				1.29	0 30	8
Arkansas.						
Blanchard Springs				1.86	0 45	18
Conway				1.50	0 45	7
Hot Springs (near)		5.25	20			
Jonesboro		2.50	19	2.50	2 00	19
Marvell				1.20	0 40	10
Moore		5.50	18-19			
Mossville				2.14	1 30	29
Paragould				1.10	0 15	9
Stuttgart				2.47	2 00	18
Colorado.						
Hoehne (near)				1.15	0 30	8
Minneapolis		3.16	17	3.16	1 30	17
Connecticut.						
Bridgeport	18.77	8.71	12-13			
Canton	16.96	7.93	12-14			
Do		4.14	22			
Do		3.38	28-29			
Colchester	10.82	2.87	12-13			
Do		3.60	22			
Falls Village	10.57	3.87	12-13			
Middletown	13.35	5.09	12-13			
Do		2.90	22			
New Haven	16.63	6.20	12-13			
Do		2.66	22			
Do		3.42	28-29			
Norwalk	10.12	3.20	12-13			
Southington	19.90	10.30	13-14			
Do		2.80	21-22			
Do		3.50	29			
Storrs	12.24	5.15	13-14			
Do		4.02	22			
Windsor	15.29	9.18	12-14			
Do		2.86	28-29			
Delaware						
Newark		2.50	26-27			
Florida.						
Bartow	14.55	2.64	12			
Do		2.82	21			
Brooksville	11.98	8.61	11-12			
Earnestville	11.33	2.70	12	1.82	1 15	9
Do				1.11	1 00	23
Fort Meade	11.81	2.64	12			
Haywood		4.10	21-22			
Macclenny				1.32	1 00	2
Manatee	11.74	2.50	22			
Myers	14.82	4.20	7	1.16	1 00	3
New Smyrna		3.95	6	1.06	1 00	10
Orange Park				1.04	0 25	24
Orlando		2.90	23	2.90	1 00	23
Oxford		4.00	12	1.70	1 00	10
Switzerland		2.78	10			
Tampa		3.25	12-13			
Tarpon Springs	10.55	3.86	11-12			
Georgia.						
Albany		4.21	2	4.21	2 00	2
Atlanta				1.79	0 45	19
Augusta		3.82	17	3.37	1 52	17
Bainbridge				1.07	1 00	1
Bellville				1.40	1 00	1
Cartersville		4.21	16			
Cedartown				1.20	1 00	3
Columbus		2.65	19	2.65	2 00	19
Eastman				1.05	1 00	6
Fort Gaines	10.08	2.81	6			
Gainesville	14.43	3.20	17-18	1.37	1 15	7
Do				1.87	0 45	8
Do				2.02	1 15	20
Do				2.25	1 15	21
Gillsville	10.94	3.60	18			
Greenbush				1.30	1 00	10
Marietta		3.88	19			
Newman				1.17	1 00	3
Quitman				1.29	0 50	20
Ramsey		2.60	19			
Savannah				1.00	0 40	5
Do				1.38	0 56	11
Do				1.92	1 00	22
Union Point		2.54	18			
Westpoint				2.03	0 10	22
Illinois.						
Carrollton		3.07	23-24			
Chemung				1.26	0 50	10
Cisne		3.95	25			
Coatsburg		3.00	24			
Illinois—Continued.						
East Peoria		2.58	10-11			
Havana		3.23	11			
New Burnside		2.91	25-26			
Peoria		2.59	10-11			
Rantoul				1.05	1 00	20
Roundgrove				1.22	0 40	10
Tuscola		3.72	9-10			
Indiana.						
Butlerville				1.35	0 30	5
Columbus		2.94	31			
Evansville		5.05	1-2			
Greensburg		2.59	20			
Huntington				1.16	1 00	10
Indianapolis				1.20	1 00	11
Do				1.45	1 00	25
Jeffersonville		4.74	10	4.74	1 45	10
Knox				1.30	1 00	16
Marion				2.33	1 00	10
Mount Vernon				1.95	1 30	10
Indian Territory.						
South McAlester				1.70	1 00	18
Iowa.						
Ames (near)		3.05	9			
Atlantic				1.26	1 00	9
Belleplaine		3.13	23			
Centerville		4.12	25			
Dubuque				2.02	2 00	9
Grundy Center				1.19	1 10	20
Guthrie Center		2.91	23			
Iowa Falls				1.07	1 00	10
Keokuk		3.62	23-24			
Keosauqua		2.95	23-24			
Lenox				1.03	1 00	17
Mount Pleasant		3.08	23-24			
Mount Vernon		4.27	22-24			
Mooar		3.25	24			
North McGregor		3.65	10	3.65	2 00	10
Osage				1.08	0 55	10
Plover		2.64	3			
Sibley		2.94	20			
Sigourney		2.81	23-24			
Stuart		3.15	9			
Do		3.36	23			
Washington		4.80	23-24			
Whitten				1.50	1 00	9
Winterset		2.95	24			
Kansas.						
Beloit		2.55	9			
Concordia		2.94	9-10			
Dodge City		3.48	19-20	1.64	1 00	19
Fall River		2.68	18			
Garden City		2.65	9-10			
Grenola		4.00	4			
Independence		3.25	18-19			
Linn		4.00	9-10			
McPherson		4.52	4			
Oswego		2.50	4-5			
Ulysses				1.05	0 30	23
Wamego		3.22	3-4			
Winona				1.00	0 30	16
Kentucky.						
Alpha				1.10	0 20	4
Bardstown				1.50	0 20	1
Do				1.24	1 00	11
Do				1.35	1 00	25
Caddo		2.60	25-26			
Edmonton		2.50	24			
Henderson		4.30	1-2			
Lexington				1.41	0 50	16
Loretto				2.39	1 30	5
Louisville				1.39	1 00	10
Marrowbone		3.02	2	3.02	3 00	2
Maysville		2.60	26			
Mount Vernon		2.60	24			
Mount Sterling				1.74	1 30	18
Scott				2.31	1 15	5
Williamsburg		2.75	19			
Louisiana.						
Amite		2.70	11-12			
Do		2.55	23			
Baton Rouge		2.70	24			
Hammond				1.57	1 00	17
Montgomery				1.00	1 00	9
Do				1.10	1 00	18
New Orleans				1.32	1 00	17
Oxford				1.44	0 31	6
Do				1.12	0 25	20
Maine.						
Cornish		3.95	13			
Fort Fairfield		4.15	12-13			
North Bridgton	13.25	5.21	12-13			
Maryland.						
Baltimore				1.36	0 23	17
Chestertown		2.51	26			
Fallston		3.25	26-27			
Frederick		2.52	26-27			
Jewell	19.90	14.75	26-27			
New Market		2.85	12			
Princess Anne	11.38			2.05	1 00	3
Solomons				1.17	0 50	28

TABLE XII.—*Excessive precipitation*—Continued.

Stations.	Monthly rainfall 10 inches, or more.	Rainfall 2.50 inches, or more, in 24 hours.		Rainfall of 1 inch, or more, in one hour.		
		Amt.	Day.	Amt.	Time.	Day.
Massachusetts.	*Inches.*	*Inches.*		*Ins.*	*h.m.*	
Amherst	13.87	5.54	12-13			
Boston				1.04	1 00	29
Hyannis		3.60				
Springfield Armory	14.99	6.55	12-13	1.15	1 05	7
Do		3.44	28-29			
Vineyard Haven		3.32	29			
Michigan.						
Bay City	10.10	5.13	12-13			
Benzonia		4.00	25-26			
Howell		3.35	26			
Jeddo		4.26	26-27			
Lansing		4.10	26			
Newberry				1.25	0 55	15
Olivet		3.07	26			
Ovid		3.00	12			
Saginaw		3.13	13			
Thomaston		5.32	25-26			
Valley Center		3.80	26			
Minnesota.						
Ada		3.28	20			
Beardsley		2.97	20			
Bermidji		3.00	6			
Bird Island		3.17	7			
Blooming Prairie		3.30	24	3.30	0 40	24
Collegeville		3.47	6			
Crookston		2.60	20			
Duluth		4.20	2-3			
Faribault		2.50	6			
Glencoe		2.94	6-7			
Glenwood		2.85	6	1.52	1 30	31
Grand Meadow		2.83	25			
Lakeside		2.75	6			
Lake Winnibigoshish		4.21	2			
Lambert		2.90	18			
Lesuer	10.80	3.00	6			
Maple Plain				1.25	0 30	2
Milaca	12.81	3.00	2			
Do		3.60	6			
Montevideo				1.15	1 00	29
Morris		4.23	2-3			
Mount Iron		3.23	8			
Park Rapids	10.16	2.53	3			
Pine River		3.95	2-3			
Pokegama Falls				1.22	0 45	2
St. Cloud	12.81	4.05	6			
Do		3.90	24	3.90	2 30	24
St. Paul				1.53	1 00	25
Sandy Lake Dam	13.41	6.52	2-3			
Tower		3.50	6			
Two Harbors		3.80	2			
Wabasha		3.44	31			
Worthington		2.58	20-21			
Mississippi.						
Austin				2.40	2 00	7
Columbus		6.60	17			
Greenville				1.19	0 30	7
Jackson				1.88	0 55	12
Lake		4.40	12-13	2.00	2 00	12
Logtown				1.88	1 00	10
Macon				1.19	1 00	9
Magnolia				1.44	0 45	27
Rosedale		3.21	18			
Vicksburg				1.70	1 00	10
Do				1.31	1 00	18
Do				1.52	0 50	20
Water Valley		3.12	18			
Waynesboro				1.20	1 00	20
Windham				1.25	1 00	9
Missouri.						
Conception				1.38	0 45	25
Farmersville		2.95	4-5			
Fulton		4.05	24-25			
Hannibal		3.31	4-5			
McCune		2.75	10			
Do		2.83	25			
Mexico		3.62	24-25			
Montana.						
Fort Custer				1.20	0 47	9
Nebraska.						
Auburn				1.95	1 00	9
Bassett		2.56	9			
Beatrice		3.10	9			
Burchard		3.75	10			
Camp Clark		3.15	18			
Chester		4.01	10			
Eden		2.77	10			
Fairbury		3.69	9-10			
Filley		3.75	9			
Hastings				1.17	0 50	9
Hickman		4.17	9			
Kennedy		2.79	19			
Kimball		4.70	18			
Odell		3.06	9			
Springfield		3.26	9-10			
Wilber		4.53	8-9			
New Hampshire.						
Concord		4.82	13			
Durham		3.56	12-13			
Grafton		2.70	12-13			
Keene		3.30	13			

TABLE XII.—*Excessive precipitation*—Continued.

Stations.	Monthly rainfall 10 inches, or more.	Rainfall 2.50 inches, or more, in 24 hours.		Rainfall of 1 inch, or more, in one hour.		
		Amt.	Day.	Amt.	Time.	Day.
New Hampshire—Continued.	*Inches.*	*Inches.*		*Ins.*	*h.m.*	
Lancaster		3.00	13-14			
Peterboro		4.60	12-13			
Sanbornton		3.44	13			
Stratford	10.00	2.65	6	1.75	1 40	6
Do		4.24	12-14			
Warner		3.92	12-13			
New Jersey.						
Asbury Park		2.58	12-13			
Atlantic City		3.76	12-13			
Barnegat	10.03	3.51	13			
Bayonne	16.96	7.03	28			
Beachhaven		3.30	13			
Belvidere	10.92	2.80	18			
Beverly	11.11					
Billingsport		4.02	28			
Blairstown		3.42	28			
Boonton	11.63					
Bridgeton	11.93	2.69	28			
Cape May C. H		3.23	23			
Charlotteburg	13.34	3.55	13			
Do		2.90	29			
Chester	12.83	2.80	14			
Do		2.75	28			
Clayton	12.22	6.03	27-28			
College Farm	12.84	5.02	28-29			
Davis	13.27	2.88	13			
Do		4.11	28			
Egg Harbor City	10.22	2.60	2			
Elizabeth	20.80	2.74	14			
Do		3.67	18			
Do		8.73	28			
Englewood	17.87	3.19	2	3.19	2 45	2
Do		3.77	28			
Freehold	13.60	2.65	21			
Gillette	10.43	2.80	26			
Hammonton	10.94					
Hightstown	12.19					
Imlaystown	10.18	2.66	12-13			
Lambertville	10.53					
Moorestown	11.35					
Newark	19.09	7.75	28-29			
New Brunswick	13.23	4.15	28			
Newton	10.87	3.70	28-29			
Ocean City		2.70	12-13			
Oceanic	12.88	3.18	14			
Do		2.78	20			
Paterson		3.05	28			
Perth Amboy	16.16	3.61	12-13			
Do		4.46	28			
Plainfield	13.92	5.02	28	2.50	2 00	28
Rancocas	12.21	3.19	12			
Roseland	11.51	2.57	28			
Sergeantsville		2.70	27-28			
Somerset	11.08					
South Orange	15.80	3.43	18			
Do		5.06	27-28			
Staffordsville	12.19	3.66	12-13			
Do		3.30	28-29			
Toms River	12.03	2.50	13			
Vineland	12.56	4.21	28	3.00	3 00	28
New York.						
Albany		3.12	13-14			
Appleton		2.60	11-12			
Arcade		2.97	11			
Bedford	11.42	2.82	13			
Brentwood	10.00	2.80	28-29			
Brooklyn	11.06	2.75	13			
Buffalo				1.67	1 00	11
Carmel	16.64	5.03	3	5.03	1 30	3
Do		3.38	29			
Catskill		2.65	14-15			
Do		2.75	28-29			
Elizabethtown	13.00	5.25	6	5.25	2 00	6
Fort Niagara		2.50	26			
Glens Falls		2.63	14			
Honeymead Brook	14.55	2.87	13	2.20	1 45	6
Humphrey		2.90	5			
Lake George		2.88	14			
Middletown		2.57	12-13			
Mohonk Lake	14.71	3.23	14			
Do		2.80	25-26			
New York		2.56	28-29			
Primrose	11.12	3.11	13			
Rochester		3.57	11-12	2.73	1 08	11
Setauket	18.18	8.60	13-14			
Do		3.35	29			
Wappingers Falls	11.84	2.61	28			
Westfield		3.05	11	3.05	2 30	11
Westpoint	13.05	6.80	13-14			
Willetspoint				1.45	1 00	23
North Carolina.						
Charlotte				1.63	1 35	10
Fair Bluff		3.67	12-13			
Fayetteville	11.11	3.36	12-13			
Do		2.97	20-21			
Greenville		2.50	20			
Hatteras		5.57	12-13	3.77	3 00	13
Kittyhawk		3.85	13			
Lumberton		2.80	20-21	1.12	1 00	9
Murphy	10.39	3.90	23-24	1.04	1 00	8

TABLE XII.—*Excessive precipitation*—Continued.

Stations.	Monthly rainfall 10 inches, or more.	Rainfall 2.50 inches, or more, in 24 hours.		Rainfall of 1 inch, or more, in one hour.		
		Amt.	Day.	Amt.	Time.	Day.
North Carolina—Continued.	*Inches.*	*Inches.*		*Ins.*	*h. m.*	
Pantego				1.05	1 00	22
Pittsboro		3.25	19-20			
Salisbury		2.80	19-20			
Selma		2.60	12-13			
Do		2.65	19-20			
Southern Pines		3.18	20			
Tarboro		3.00	7-8			
Waynesville				1.17	1 10	8
Willeyton				1.20	1 00	7
Wilmington		2.60	25	2.25	1 00	25
North Dakota.						
Amenia		5.13	19-20			
Bordulac		2.60	21			
Devils Lake		3.20	21			
Fargo		2.80	20			
Gallatin		2.70	20			
Hamilton		4.43	20			
Langdon		3.47	21			
Mayville		3.23	20-21			
Milton		4.50	21			
Minto		2.77	20			
Minnewaukon		3.17	21			
Power		6.55	19-20			
Sheyenne		3.20	20-21			
University		3.85	19-20			
Wildrice		5.86	19-20			
Ohio.						
Ashtabula	10.69	4.00	5-6			
Do		4.48	18			
Bement		4.12	20-21			
Cambridge				1.14	1 05	18
Canfield	10.55	5.40	21-22			
Cincinnati				1.99	1 00	5
Colebrook		2.64	22	2.64	1 30	22
Columbus		3.81	11	2.68	0 56	11
Fayetteville	10.42	3.63	5	3.00	1 30	5
Do		3.71	24			
Greenville				1.75	1 00	5
Hudson				1.30	1 00	5
Leipsic		2.55	10	2.55	1 10	10
Lordstown		4.30	11	4.00*	2 00*	11
Milligan		2.75	6	2.75	2 00	6
New Moscow		3.40	26			
Norwalk		2.67	20			
Philo		3.59	11-12			
Plattsburg		3.55	21			
Sandusky				1.30	1 00	5
Toledo				1.10	1 00	18
Vermillion				1.40	1 00	26
Vickery				1.22	0 45	19
Waynesville				1.22	1 00	11
Westerville		2.66	5	2.66	2 00	5
Zanesville		2.99	11-12			
Oklahoma.						
Beaver		3.28	19-20	2.57	0 38	19
Do				1.25	1 00	24
Oklahoma				1.24	1 00	24
Pennsylvania.						
Brookville		5.20	21			
Elwood Junction	10.94	2.81	22			
Forks of Neshaminy	12.42	3.33	21-22			
Hamburg		2.60	18			
Kennett Square	10.16	3.23	22	1.03	0 55	2
Do		2.65	26-27			
Philadelphia (V. O.)	10.25					
Point Pleasant		2.99	18			
Pottstown		2.80	27			
Reading		2.51	27			
Saegerstown	14.51	3.05	11	3.05	2 00	11
Do		5.81	17-18			
Shawmont	11.45	4.96	21-22			
Do		3.39	27-28			
Shinglehouse				1.14	0 45	20
Smiths Corners	10.22	3.89	18			
Swarthmore	10.43					
Swiftwater	13.10	4.50	21	4.00	3 45	21
Wellsboro				1.00	0 40	11
West Chester		3.24	22			
South Carolina.						
Allendale				1.92	1 00	12

TABLE XII.—*Excessive precipitation*—Continued.

Stations.	Monthly rainfall 10 inches, or more.	Rainfall 2.50 inches, or more, in 24 hours.		Rainfall of 1 inch, or more, in one hour.		
		Amt.	Day.	Amt.	Time.	Day.
South Carolina—Continued.	*Inches.*	*Inches.*		*Ins.*	*h. m*	
Batesburg		2.75	18	1.15	0 50	13
Charleston		3.29	26-27	1.02	0 30	10
Do				1.10	0 45	25
Do				1.54	1 00	27
Cheraw				2.10	1 10	9
Florence				1.88	0 45	9
Gillisonville				1.12	0 45	1
Greenville		2.65	11-12			
Pinopolis		2.72	4			
St. Georges		2.50	12	2.50	1 50	12
Do				1.30	1 00	13
St. Matthews				1.43	1 20	27
St. Stephens				1.22	1 00	22
Do		5.15	26-27	3.53	3 00	27
Yorkville		2.51	4			
South Dakota.						
Castlewood		3.15	19-20			
Howard				1.30	1 00	31
Pierre		2.89	18-19			
Sioux Falls		2.74	19-20			
Watertown		3.45	19-20			
Tennessee.						
Arlington		3.00	11			
Carthage		3.45	15-16			
Erasmus	10.64	3.07	15-16			
Do		2.87	24-25			
Fairmount		2.71	16			
Do		2.75	24-25			
Grace				1.20	0 40	2
Do				1.00	1 00	15
Do				2.06	1 50	16
Harriman	10.10	3.89	24-25			
Lynnville		2.58	6	2.52	2 00	6
Nashville				1.83	1 00	4
Do				1.08	1 00	10
Do				1.30	0 47	11
Do				1.04	1 00	15
New Market		2.70	16	2.21	1 00	2
Oak Hill	13.21	3.90	24			
Palmetto				2.05	1 30	3
Rugby		2.75	15-16			
Tellico Plains		2.52	25			
Tracy City		3.20	16			
Tullahoma				1.15	1 00	25
Texas.						
Ballinger				1.42	0 45	28
Forestburg		3.00	17	3.00	1 00	17
Gainesville		3.55	17	2.40	1 30	10
Rheinland		2.77	16			
Sulphur Springs				2.02	2 00	17
Tyler				1.16	1 00	17
Vermont.						
Brattleboro	12.09					
Burlington		2.87	13-14			
Chelsea	10.60	3.72	6	3.72	1 30	6
Cornwall		2.61	13-14			
Enosburg Falls	12.73	4.06	14			
Do		2.91	24			
Jacksonville	10.31	3.04	14			
Northfield				1.67	1 00	6
Vernon	13.65	2.89	28			
Wells	10.07	2.95	14			
Virginia.						
Ashland				1.56	0 30	27
Farmville		3.25	20			
Goshen		2.50	21	2.00	0 30	17
Lynchburg		2.73	21	2.15	0 50	1
Do				1.43	0 25	21
Wisconsin.						
Barron				2.15	1 00	9
Butternut	15.11	10.15	24-25			
Harvey				1.98	1 20	10
Medford		2.50	26			
Portage				1.15	1 00	9
Prairie du Chien		3.39	10	3.39	1 45	10
Spooner				1.00	1 00	7

*Estimated.

Chart I. Tracks of Centers of High Areas. July, 1897.

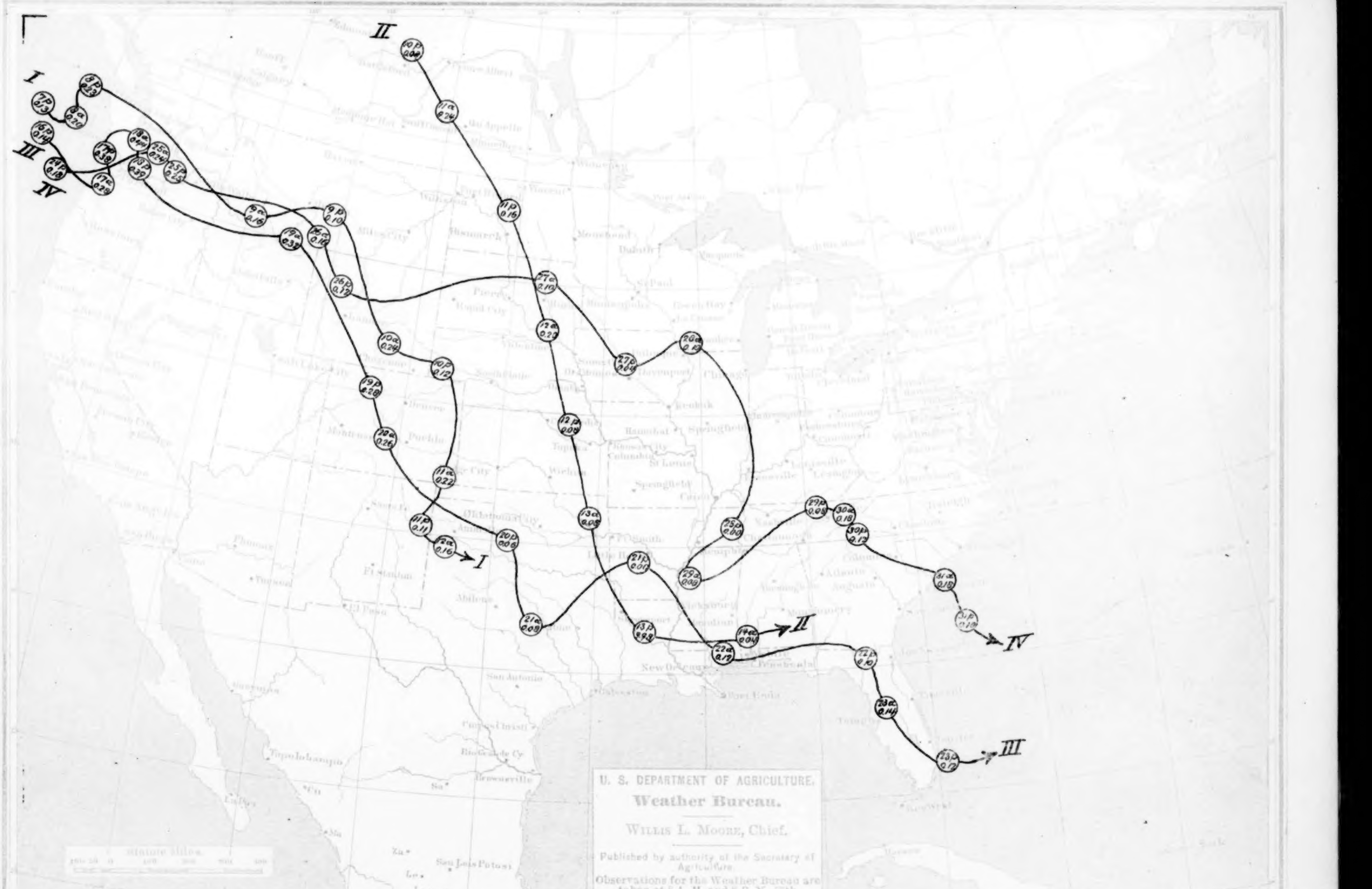

Chart II. Tracks of Centers of Low Areas. July, 1897.

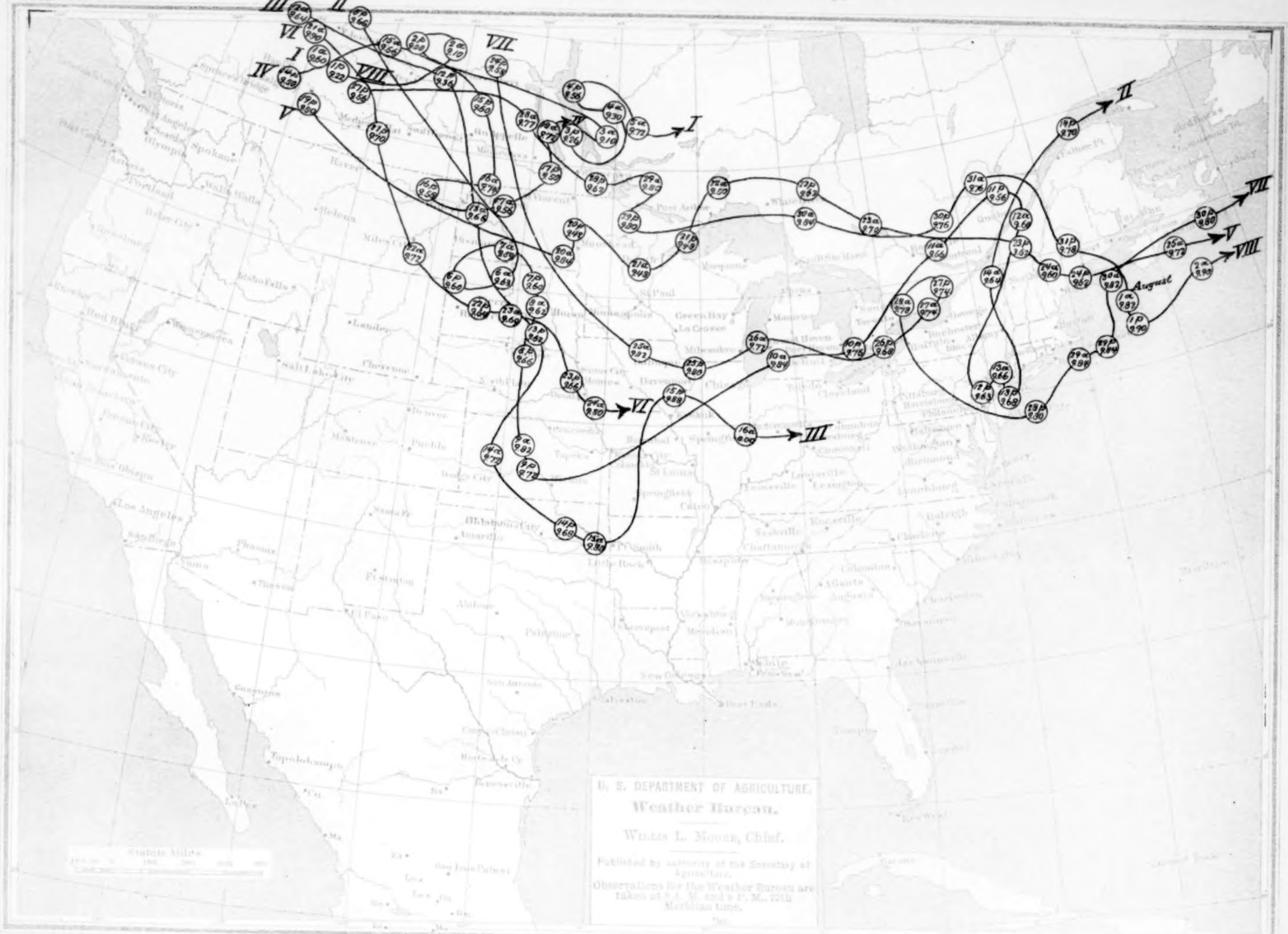

Chart III. Total Precipitation. July, 1897.

Chart III. Total Precipitation. July, 1897.

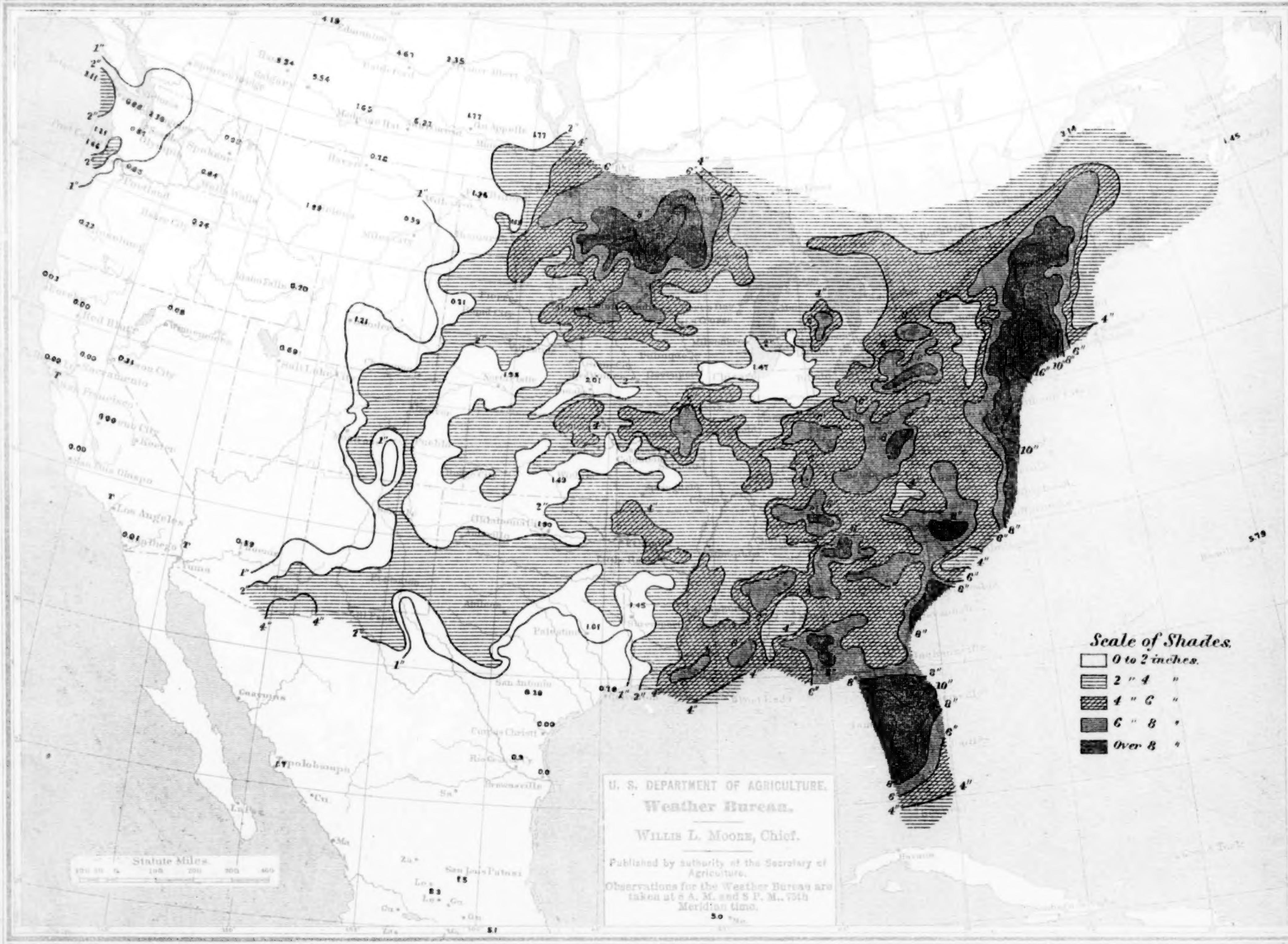

Chart IV. Isobars, Isotherms, and Resultant Winds. July, 1897.

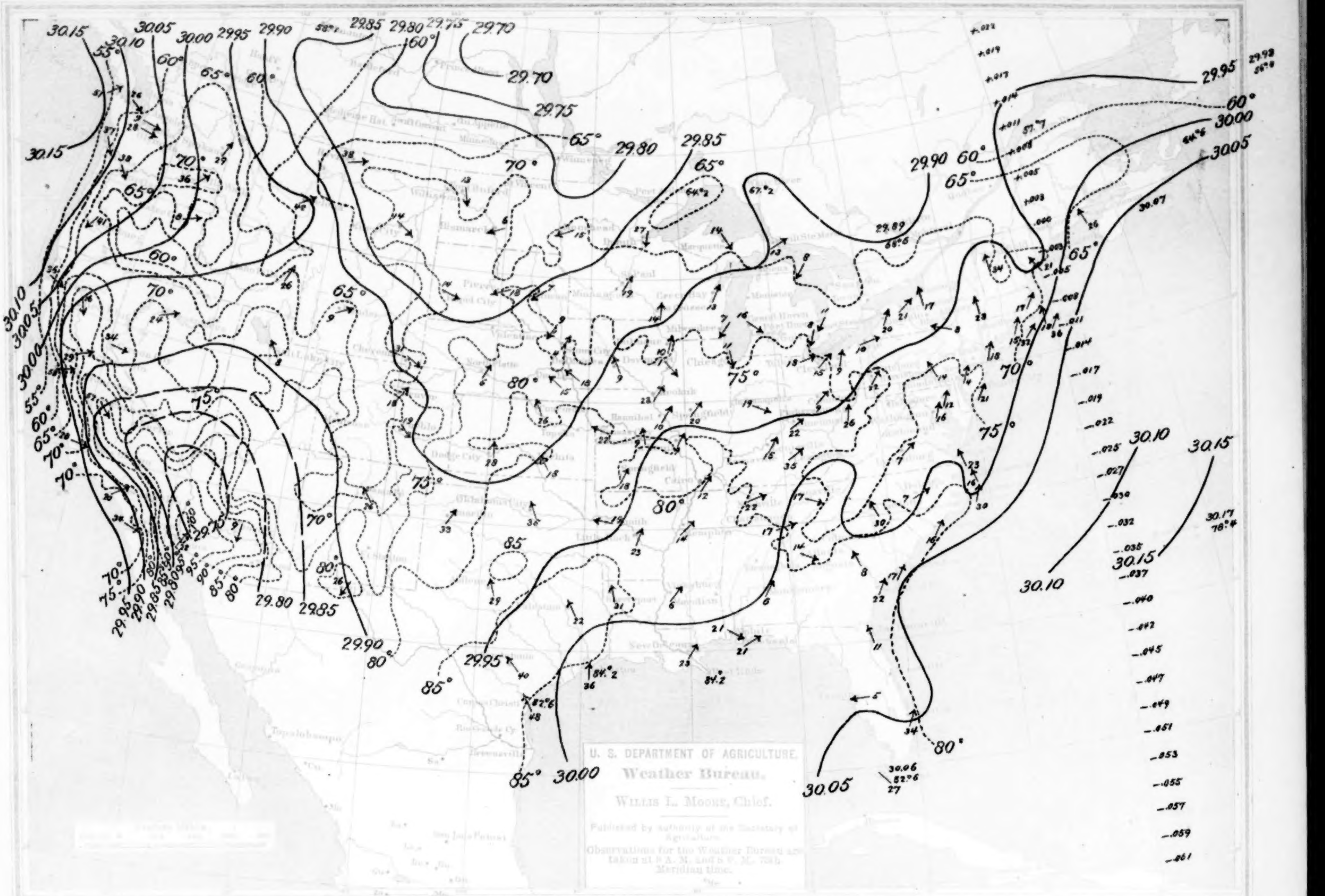

Chart V. Hydrographs for Seven Principal Rivers of the United States.